INDEX

mercruiser

SERVICE MANUAL

Number 4

Stern Drive Units

MCM 120 - 260

Sections 1 thru 7

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Printed in U.S.A.

90-86137 286

MODELS COVERED IN THIS MANUAL

TRANSOM ASSEMBLIES	
Model	**Serial Number**
MCM 120/140/165/ 470/485/898/228/260	4891650 - 6216686

MC 120 - 260 STERN DRIVE UNITS	
Ratio	**Serial Number**
1.98:1	4893635 - 6237860
1.84:1	4893835 - 6225576
1.65:1	4890460 - 6268064
1.50:1	4898730 - 6229157

INDEX

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I-DRIVE
SERVICE MANUAL
OUTLINE

SECTION 1 - General Information

SECTION 2 - Troubleshooting

SECTION 3 - Drive Unit

PART A - Drive Shaft Housing Assembly

PART B - Gear Housing Assembly

SECTION 4 - Transom Plate Assembly

SECTION 5 - Power Trim

SECTION 6 - Power Steering

SECTION 7 - Service Bulletins

NOTICE TO USERS OF THIS MANUAL

This service manual has been written and published by the service department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

REPLACEMENT PARTS

⚠WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

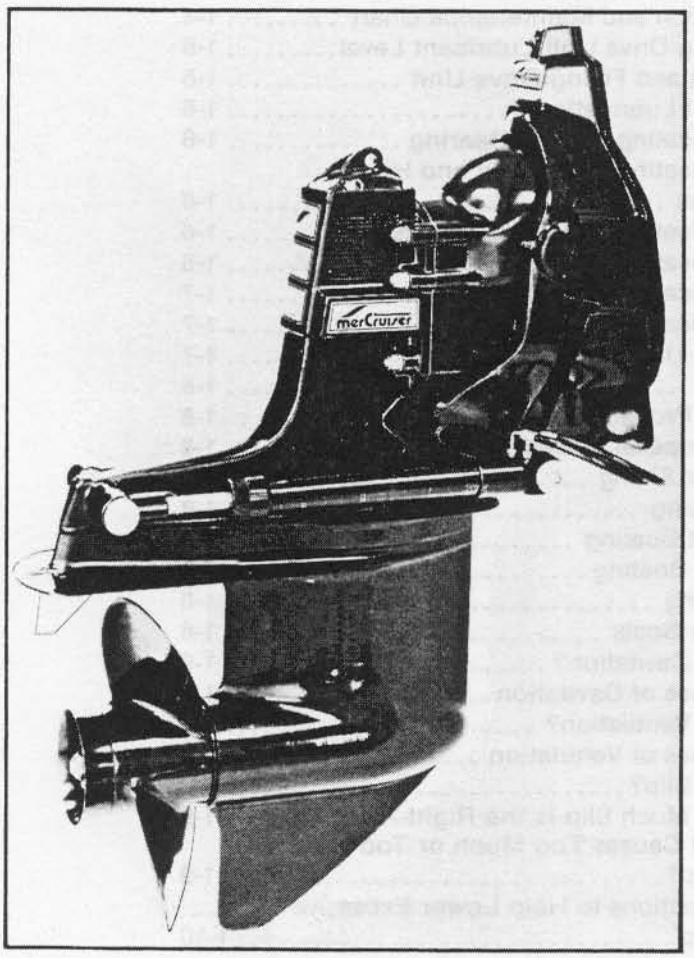
Failure to use recommended Quicksilver service replacement parts can result in poor performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

SECTION 1

I-DRIVE

General Information



INDEX

Page

Important Safety Notification 1-1
Electrical Replacement Parts 1-1
Notice 1-1
General Information 1-2
Directional Reference 1-2
Serial Number Locations 1-2
Steering and Shift Cable Requirements 1-2
Steering Cable Requirement 1-2
Shift Cable Requirement 1-2
Determining Steering Cable Length 1-3
Determining Shift Cable Length 1-3
Lubrication and Maintenance 1-4
Lubrication and Maintenance Chart 1-4
Checking Drive Unit Lubricant Level 1-5
Draining and Filling Drive Unit 1-5
Points of Lubrication 1-6
Lubricating Gimbal Bearing 1-6
Lubricating Swivel Pin and Hinge Pins 1-6
Lubricating U-Joint Bearings 1-6
Lubricating Steering System 1-6
Lubricating Propeller Shaft 1-7
Lubricating Shift Linkage 1-7
Stern Drive Unit Storage 1-7
Propellers 1-8
Correct Propeller 1-8
What Propeller Is Best? 1-8
Water Skiing 1-8
Cruising 1-8
Sport Boating 1-8
Bass Boating 1-8
Fishing 1-8
Work Boats 1-8
What Is Cavitation? 1-9
Causes of Cavitation 1-9
What Is Ventilation? 1-9
Causes of Ventilation 1-9
What Is Slip? 1-9
How Much Slip Is the Right Amount? 1-9
What Causes Too Much or Too Little Slip? 1-9
Corrections to Help Lower Excessive Slip 1-10
Guidelines for Selection of Best Quicksilver Stainless Steel Propellers 1-10
Conventional Quicksilver Stainless Steel Propeller Selection 1-10
High Performance (Cleaver) Propeller Selection 1-10

IMPORTANT SAFETY NOTIFICATION

Correct service and repair is important for the safe, efficient operation of all mechanical products. The service procedures, that are recommended and described in this service manual, are effective methods for performing service operations.

Some repair procedures require special tools which should be used where specified and as recommended. Pay special attention to the "Safety Warnings" and/or "Cautions" (printed in bold type in this manual) which relate to a specific service procedure that can damage the product, render it unsafe or cause personal injury. Remember, however, that these "Safety Warnings" and/or "Cautions" are not all-inclusive.

We could not possibly know of and advise the service trade of all conceivable procedures in which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by us, first must completely satisfy oneself that neither one's nor the product's safety will be endangered by the service procedure selected.

ELECTRICAL REPLACEMENT PARTS

SAFETY WARNING: Electrical system components on MerCruiser Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical systems, it is extremely important that all components are properly installed and tightened. If not, any electrical component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

NOTICE

The following special information will alert you to possible dangers and to important information in this manual. Observe them carefully. "Safety Warnings" and "Cautions" (outlined in a border) alone do not eliminate the dangers that they signal. Your close attention to implement them, plus "common sense" operation are major accident prevention measures.

SAFETY WARNING	**Failure to follow a "Safety Warning" may result in bodily injury.**
CAUTION	**Non-compliance with "Caution" instructions may result in failure or damage to the product and/or equipment.**

IMPORTANT — **Is used to indicate required service procedure.**

NOTES: Are used to indicate preferred service procedures and/or exceptions.

GENERAL INFORMATION

Directional Reference

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this service manual, all directional reference are given as they appear when viewing boat from stern, looking toward bow. (Figure 1)

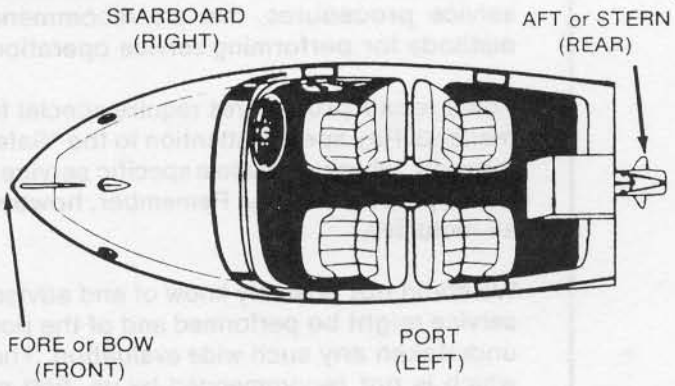


Figure 1. Directional Reference

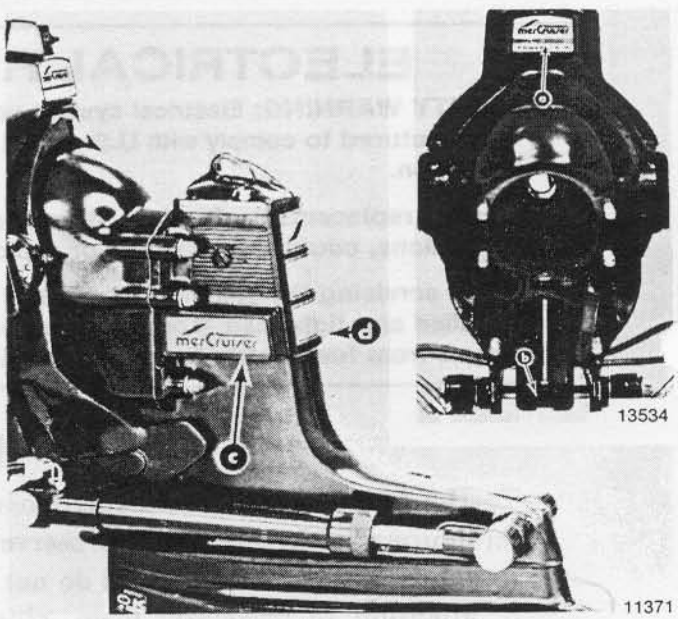
Serial Number Locations

IMPORTANT: Serial numbers are the manufacturer's key to numerous engineering details applicable to the unit. When ordering parts, accessories and tools, or when corresponding with the manufacturer or dealer in regard to service matters, always specify stern drive and/or transom assembly serial number.

The transom assembly serial number location is permanently stamped on the bell housing gasket surface. For quick reference, the serial number also will be located on gimbal housing decal. (Figure 2)

The stern drive unit serial number is stamped on the drive shaft housing under MerCruiser decal on left side of housing. Serial number also is on the decal on rear of drive shaft housing. (Figure 2)

Both transom assembly and stern drive unit serial numbers are stamped in a pressure sensitive decal (located on side of engine rocker arm cover).



a - Decal Location on Gimbal Housing
b - Bell Housing Gasket Surface
c - Serial Number under Side Decal
d - Serial Number on Rear Decal

Figure 2. Transom Assembly (Top Illustration) and Stern Drive Unit Serial Number Locations

STEERING and SHIFT CABLE REQUIREMENTS

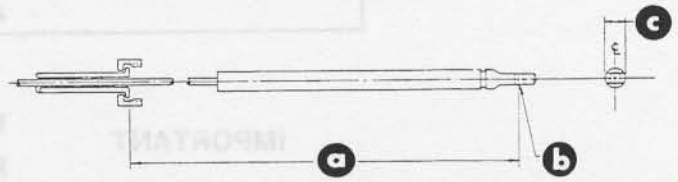
STEERING CABLE REQUIREMENT

CAUTION: If a steering cable with the wrong end dimensions is installed on a MerCruiser Power Steering System, severe damage to the steering system and the Power Steering pump will occur.

Total travel should be 8½" ± ½" (21.6cm + 12.7mm) minimum travel of 4" (10.2cm) each side of mid-travel position; maximum travel of 4½" (11.4cm) each side of mid-travel position. (Figure 3)

SHIFT CABLE REQUIREMENT

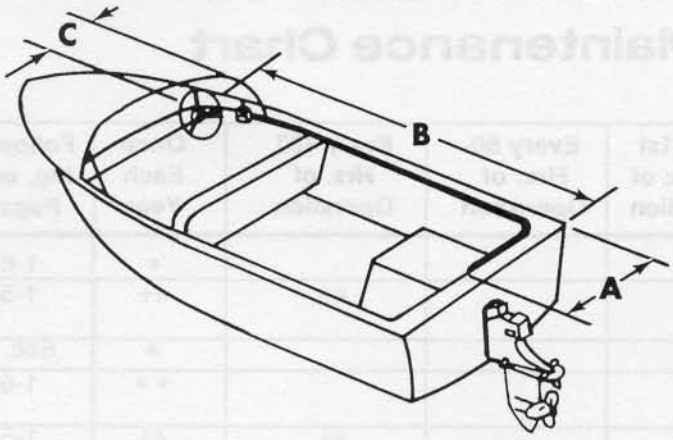
Total travel of remote control shift cable, that is used on MerCruiser I Stern Drives, should be 3¼" (83mm), 1⅝" (41.3mm) on each side of mid-travel point. If these dimensions are not complied with, the stern drive will not shift properly into both forward and reverse.



a - 16-7/8" (42.9cm) Mid-Travel Position
b - .385" ± .005" (9.8mm ± 0.13mm) Diameter Drill Thru
c - 5/8" (15.9mm) Maximum Diameter

Figure 3. Steering Cable Travel

DETERMINING STEERING CABLE LENGTH



NOTE: The following boat measurements are to be taken on the inside of boat.

1. Add boat measurements A-B-C, where

   A = Distance in inches (or centimeters) from the center of engine to the starboard side of boat.
   B = Distance (in inches) from transom to dashboard.
   C = Distance (in inches) from center of steering wheel (helm) to starboard side of boat.

   NOTE: For port (left) side cable routing, use the same measuring procedure, except take measurements "A" and "C" from opposite side of boat.

2. Subtract 6" for In-Line models with Power Steering. Add 6" for In-Line models without Power Steering and V-8 models.
3. Divide above measurement by 12".
4. This is the cable length in feet for ordering. After cable length in feet has been determined, order as follows:

   Example:
   Measured 15' - order 14'6" cable (C-76___A14)
   Measured 15' 1" - order 15' 6" cable (C-76___A15)

   NOTE: This cable measuring procedure allows for an 8" minimum radius at 2 cable bending points. On boats with unusual cable routing or considerable freeboard drop, it may be necessary to adjust cable length slightly.

Metric Scale: 1" (inch) = 2.54cm; 1' (ft.) = 30.5cm

DETERMINING SHIFT CABLE LENGTH

IMPORTANT: When selecting and installing shift and throttle cables (in the following steps), be sure to adhere to the following:

- Choose correct length cable. (A cable of improper length will cause hard shift and throttle operation.)
- Cable should follow the shortest route possible to the engine.
- Cable should be allowed to protrude down or out from remote control and should not be fastened to boat for at least 3' (91.4cm) from control. (This will prevent placing a load on cables when operating control.)
- Bends should be kept to a minimum and should not form less than a 12" (30.5cm) radius.
- Use only Quicksilver cables with Quicksilver Remote Controls.

Determine correct length shift and throttle cable (C-34555A ____) required, as follows:

1. Measure the route (in inches or centimeters) that each cable will follow. Measure from cable anchor point on control to shift lever fixed stud (for right-hand cable installation) or to anchor stud on shift plate (for left-hand cable installation). Be sure to allow sufficient cable length to allow cables to protrude straight down or out from control and to make gradual bends with not less than a 12" (30.5cm) radius.
2. Add 6" (15.2cm) to this measurement.
3. If measurement was taken in centimeters, divide total by 2.54 to convert total to inches. Round total off to nearest inch.
4. Divide total by 12 to obtain cable length in feet.
5. Select correct length cable. If measurement obtained contains a fraction of a foot, always select next highest length cable. Use the following examples if necessary.

   Measured 15' 0" - Use 15' cable (C-34555A15)
   Measured 15' 1" - Use 16' cable (C-34555A16)

LUBRICATION and MAINTENANCE

Lubrication and Maintenance Chart

Check the Following	After 1st 20 Hrs. of Operation	Every 50 Hrs. of Operation	Every 100 Hrs. of Operation	Once Each Year	Following, on Page
Bellows	Δ			•	1-6
Drive Unit Swivel Shaft and Swivel Pin Lubricate	4+		4+	4+	1-5
Drive Unit to Engine Alignment, Check				•	Sec. 3
Exterior, Clean and Check Drive Unit Painted Surface				+•	1-6
Gimbal Bearing, Lubricate	4+		4+	4+	1-5
Hinge Pins, Lubricate	4Δ	4Δ		4Δ	1-5
Power Steering Control Valve (if Equipped), Lubricate	4Δ	4Δ		4Δ	1-6
Power Steering Fluid Level (if Equipped), Check	2	2		2	1-6
Power Steering Extension Rod (on V-8's Only), Lubricate	7Δ	7Δ		7Δ	1-6
Power Trim Pump Oil Level, Check	6		6	6	1-6
Propeller, Check for Possible Damage §	•	•		•	1-6
Propeller Shaft Splines, Lubricate				5	1-6
Shift Control, Lubricate				4	
Shift Linkage, Lubricate				4	1-6
Steering Cable Exposed Portion, Lubricate		7		7	1-5
Steering Cable, Lubricate	4+	4Δ		4Δ	1-5
Steering Linkage, Lubricate	1+	1+			1-5
Steering Head, Lubricate				4	1-5
Steering System for Excessive Wear or Looseness			•	•	1-5
Stern Drive Oil Level, Check	3	3			1-4
Stern Drive Unit Oil, Change			3	3	1-4
Trim Cylinder Fasteners, Tighten	• +		•		1-6
Trim Tab and Anodic Plate, Check Condition		Every 30 days +			1-6
U-Joint Coupling Splines, Lubricate			4	4	1-5
U-Joint Cross Bearings, Lubricate			4	4	1-5
Water Pump Impeller, Check (Necessary to Separate Drive Shaft Hsg. from Gear Hsg.)				8	1-6

1 - Use Formula 4 Quicksilver Oil
2 - Use ATF Type "F" or Dexron
3 - Use Quicksilver Super-Duty Lubricant
4 - Use Universal Joint Lubricant
5 - Use Perfect Seal
6 - SAE 10W-30 or SAE 10W-40
7 - Use Special Lubricant 101
8 - On "V-8" models with Closed Cooling, inspect impeller inside water pump mounted on engine (refer to "Engine Installation Manual" by model).

+ If unit is operated in salt water, requires more frequent attention.
Δ Every 60 days in fresh water; every 30 days in salt water.
§ Check that nut is secure.

NOTE: Complete list of maintenance is not applicable to all models. The above chart is based on average operating conditions. Under severe operating conditions, continuous heavy duty or high speed operation, the inspection and maintenance intervals should be shortened.

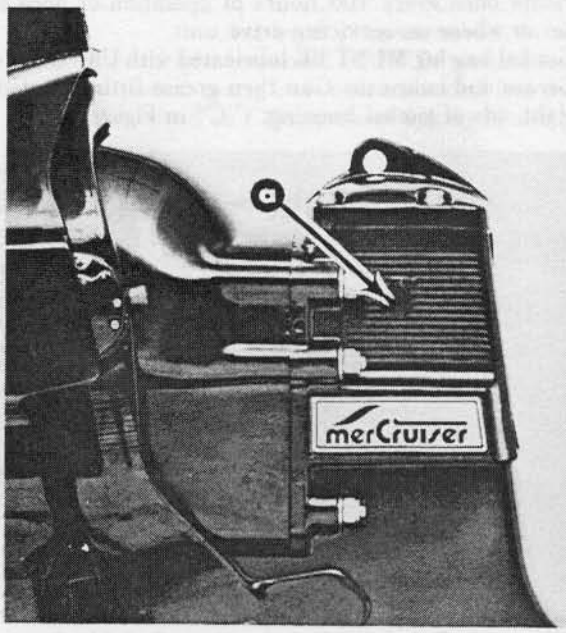
Checking Drive Unit Lubricant Level

SAFETY WARNING: DO NOT remove "Vent" or "Fill" plug when drive is hot from operation. Expanded hot gear lubricant would be released thru hole. Check only when stern drive unit is cool.

CAUTION: DO NOT use regular automotive grease in stern drive unit.

CAUTION: If lubricant appears milky brown, or if large amounts of lubricant must be added to fill stern drive unit, a leak is indicated, and drive unit should be checked promptly.

1. Remove "Vent" plug and gasket from side of drive shaft housing. (Figure 4) Lubricant must be even with bottom edge of threaded "Vent" hole when unit is level.
2. If level is low, add Super-Duty Gear Lubricant thru "Vent" hole. If more than 2 ounces (59ml) of lubricant are added to drive unit, then a leak is indicated, and it will be necessary to check the drive unit to determine the cause. After cause has been found, and lubricant level is more than 2 ounces low, fill drive unit according to "Draining and Filling Drive Unit" instructions, following.
3. After bringing lubricant level up to bottom of "Vent" hole, install "Vent" screw with new seal gasket.



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a - Vent Screw

Figure 4. Vent Screw Location

Draining and Filling Drive Unit

SAFETY WARNING: DO NOT remove "Vent" or "Fill" plug when drive unit is hot from operation. Expanded hot gear lubricant would be released thru plug hole. Check only when stern drive is cool.

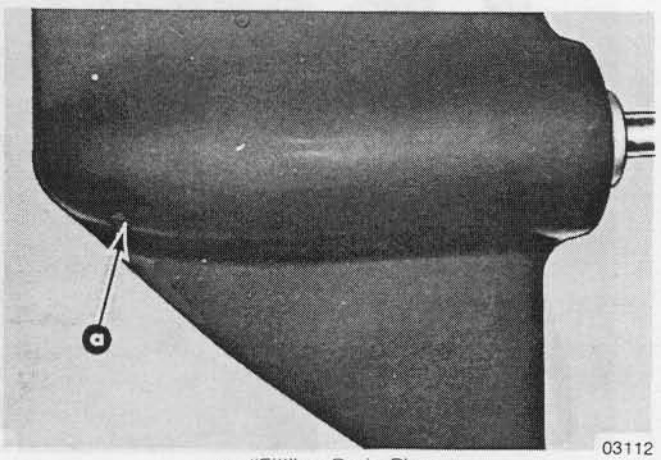
CAUTION: DO NOT use regular automotive grease in stern drive unit.

CAUTION: If more than one teaspoonful of water drains from the filler hole, or if lubricant appears milky brown, or if large amounts of lubricant must be added to fill the stern drive unit, it should be checked promptly to determine problem.

Use only Quicksilver Super-Duty Gear Lubricant. Lubricant should be changed once every 100 hours of operation or once each season. DO NOT attempt to fill drive unit with lubricant thru "Vent" hole, or air pockets will form and eventually cause drive unit failure.

1. Drain stern drive unit by removing drain plug from lower end of gear housing on left side (Figure 5) and "Vent" plug on upper drive shaft housing. (Figure 4)
2. To refill drive unit, insert lubricant tube into drain hole in lower unit (Figure 5) and inject lubricant until air-free excess fluid starts to flow out of "Vent" hole in upper drive shaft housing. (Figure 4)
3. Without removing lubricant tube from gear housing, install "Vent" screw, being sure that gasket is in position on screw and in good condition.
4. Remove lubricant tube, then quickly install "Fill" screw, being sure that gasket is in position on screw and in good condition.

NOTE: After filling a stern drive unit, that has been drained of all lubricants, the lubricant level must be rechecked after a "run-in" period of about one minute. This procedure assures that any air pockets, which may have developed during filling, will be eliminated. Additional lubricant may have to be added after rechecking to "top off" the oil level.



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a - "Fill" or Drain Plug

Figure 5. Filler or Drain Plug Location

Points of Lubrication

LUBRICATING GIMBAL BEARING

Lubricate once every 100 hours of operation or once each season or whenever servicing drive unit.

1. Gimbal bearing MUST BE lubricated with Universal Joint Grease and Lubricant Gun thru grease fitting located on right side of gimbal housing. ("C" in Figure 6)

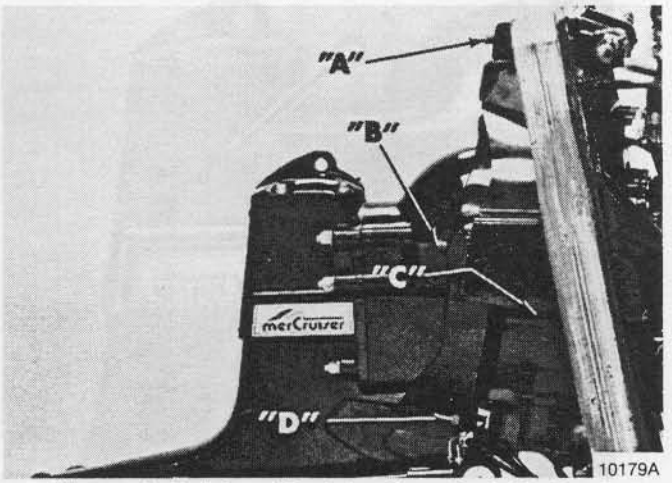
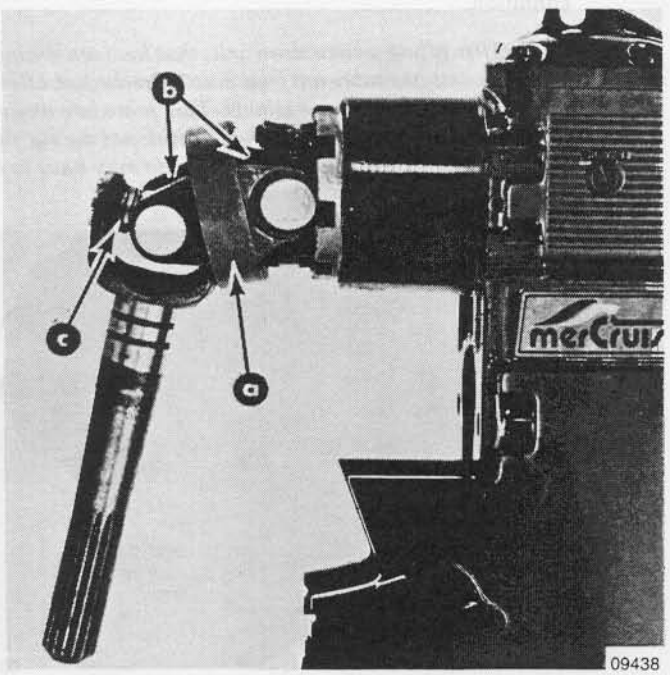


Figure 6. Points of Lubrication, Outside Boat

2. Remove protective cap and insert approximately one ounce (30ml) with lubricant gun.
3. Reinstall protective cap to grease fitting after lubricating gimbal bearing.

LUBRICATING SWIVEL PIN and HINGE PINS

Apply Universal Joint Grease to gimbal housing upper ("A") and lower ("D") swivel pins and to hinge pins ("B"). (Figure 6)



a - U-Joints b - Grease Fittings c - Seals (8)

Figure 7. Lubricating U-Joint Bearings

LUBRICATING U-JOINT BEARINGS

Lubricate stern drive universal joint bearings (and splines) at specified intervals with Universal Joint Lubricant.

1. Remove drive unit from gimbal housing (refer to "Drive Shaft Housing - Removal"; see "Index").
2. Inject Universal Joint Lubricant into both grease fittings (Figure 7) until new grease appears around seals.
3. Apply Universal Joint Lubricant to shaft splines before reinstalling drive unit.

LUBRICATING STEERING SYSTEM

1. Lubricate Ride-Guide Steering cable through grease fitting ("A" in Figure 8, 9 or 10) on transom end of cable with Universal Joint Grease only when cable is fully retracted. If cable is lubricated while extended, hydraulic lock could occur.

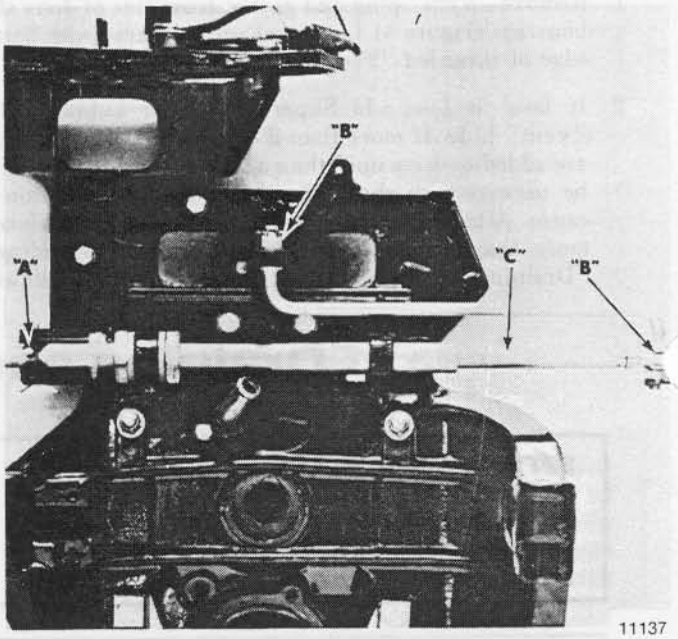


Figure 8. Lubrication Points Inside of Boat (In-Line with Manual Steering)

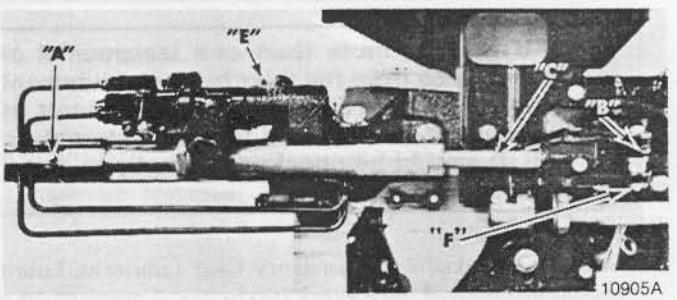


Figure 9. Lubrication Points Inside Boat (In-Line with Power Steering)

NOTE: Ride-Guide Steering cable is lubricated at the factory and requires no additional lubrication at initial installation.

2. Lubricate all pivot points ["B" and "D" (if equipped) with 20W engine oil] at intervals listed in "Lubrication and Maintenance Chart", preceding.
3. With steering cable fully extended, coat exposed portion of steering cable "C" with Special Lubricant 101 at intervals

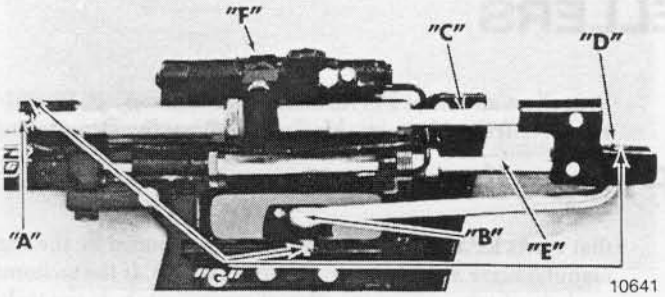


Figure 10. Lubrication Points Inside Boat ("V-8's")

listed under "Lubrication and Maintenance Chart", preceding.

4. Lubricate Power Steering control valve ("E" in Figure 9) or ("F" in Figure 10) thru grease fitting with Universal Joint Grease (until grease appears around rubber boot).
5. On "V-8" installations, lubricate extension rod ("E" in Fig. 10) when fully extended with Special Lubricant 101.
6. Check all connections for loose fasteners and/or wear while performing lubrication.

LUBRICATING PROPELLER SHAFT

SAFETY WARNING: To prevent accidental starting of engine while removing and installing propeller, be sure that the remote control is in neutral and that the ignition key is removed from switch.

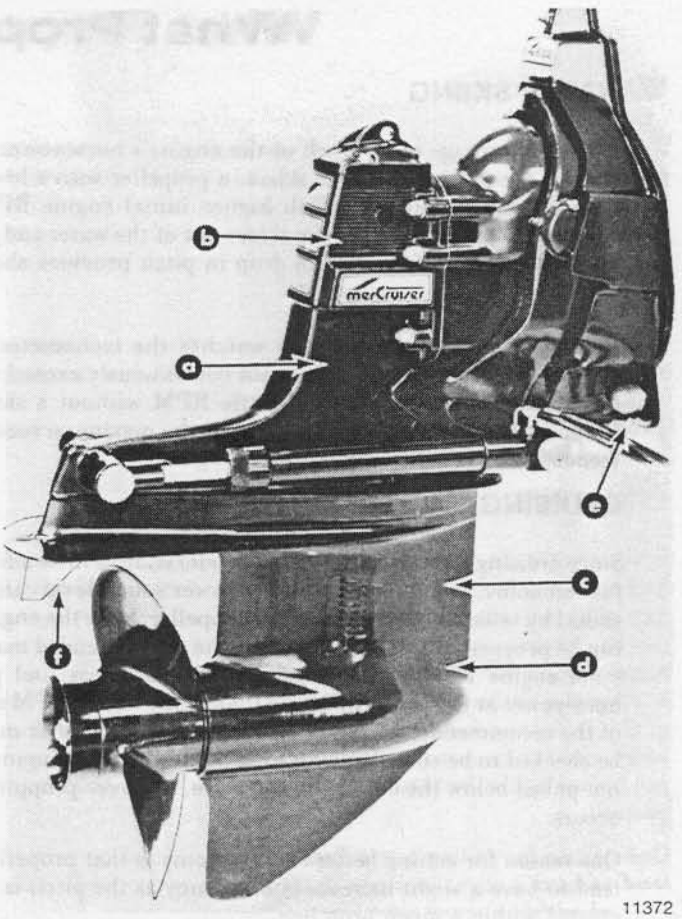
Periodically lubricate propeller shaft with Perfect Seal to prevent propeller from seizing to shaft. Remove propeller, coat propeller shaft with Perfect Seal and install propeller, as explained under "Stern Drive Unit - Installing Gear Housing" (see Service Manual "Outline" page in front of book).

LUBRICATING SHIFT LINKAGE

1. Remove nuts, washers and cotter pin which secure shift cables to shift bracket, then remove cables without disturbing adjustments.
2. Lubricate studs and recess with Universal Joint Lubricant and reinstall cables. Be sure to tighten nuts, then back off ½-turn.

STERN DRIVE UNIT STORAGE

1. Drain stern drive lubricant. (Refer to "Draining and Filling Drive Unit", preceding.)
2. Separate gear housing from drive shaft housing and check condition of water pump impeller. Replace if impeller is worn, hardened or set. Refer to "Drive Unit" Section 3.
3. Reassemble drive unit, then remove drive unit from gimbal housing and check drive unit to engine alignment. (Refer to "Drive Unit" Section 3.)
4. Lubricate universal joint bearings (2 grease fittings) with Universal Joint Lubricant.
5. Lubricate universal joint splined shaft and engine coupling with Universal Joint Lubricant.
6. Check condition of bellows and clamps.
7. Install drive unit back to gimbal housing and fill drive unit with Super-Duty Gear Lubricant. (Refer to "Draining and Filling Drive Unit", preceding.)
8. Perform all procedures according to instructions under "Points of Lubrication", preceding.
9. Check Power Steering fluid level, if applicable.
10. Check Power Trim pump oil level.
11. Check condition of drive unit painted surface. Clean and paint metal surfaces that have become exposed. Spray stern drive exterior with Corrosion and Rust Preventive.
12. Open water drain holes (one located in gear housing and 2 in drive shaft housing), using a piece of wire to check that they are open. (Figure 11)
13. Check all fasteners for tightness.
14. Check complete steering system for excessive wear or looseness.
15. Check condition of trim tab and anodic bolt heads. (Figure 11) Replace if necessary.
16. Store unit in full "down" position. The universal joint bellows may develop a "set", if unit is stored in a tilted-up position, and result in bellows failure when unit is returned to service. Drive unit may be stored OFF boat and installed prior to service.



a - Drive Shaft Housing
b - Water Drain (One Each Side)
c - Gear Housing
d - Water Drain
e - Anodic Bolt Heads
f - Trim Tab

Figure 11. Water Drain Locations

PROPELLERS

For complete information on propeller theory and boat performance read "What You Should Know About Quicksilver Propellers and Boat Performance Information" (C-90-86144), available from Mercury Marine Publications Department.

Correct Propeller

Diameter and pitch, the 2 most important propeller characteristics, are measured in inches. Propeller pitch usually is stamped on the hub. If diameter also is stamped on the propeller, this number would be listed first.

Example: 15-1/4 x 21 = Diameter x Pitch in Inches

Incorrectly propped, a boat can suffer reduced top speed, poor acceleration and poor fuel economy. It even can shorten engine and/or drive life by either overloading the engine or allowing excessive RPM. Correct propellers are found in prepared charts, catalogs or Boat House Bulletins. Here, the testing has been done for you, and correct propeller sizes are listed for typical boats of various weights and styles.

Check for the correct propeller by test running the boat, using an accurate tachometer. Basically, the correct propeller is one that turns RPM within the range recommended by the engine manufacturer at wide-open-throttle (WOT). If the tachometer reads too high, use a propeller of greater pitch. If the tachometer reads too low, use a propeller of lower pitch.

Under certain operating conditions, such as overloading of a boat or pulling water skiers, it may be necessary to reduce propeller pitch to again allow the engine to turn up to its recommended RPM. By doing this, better acceleration and overall performance will result.

CAUTION: If, at any time, operating conditions change to where a boat is no longer overloaded or water skiers are no longer pulled, the original propeller should be reinstalled to prevent engine damage caused by excessive RPM.

What Propeller(s) Is Best?

WATER SKIING

To take advantage of as much of the engine's horsepower as possible for pulling up water skiers, a propeller with a lower pitch should be selected. With higher initial engine RPM, more thrust is developed to pop skiers out of the water and get the boat on plane faster. Each drop in pitch provides about 10% more thrust.

It's important that the operator watches the tachometer to make sure that engine RPM does not continuously exceed the maximum recommended full throttle RPM without a skier. Propping the engine at or a little above the maximum recommended limit is called "under-propping".

CRUISING

Since cruising does not require top acceleration, a little added fuel economy, less engine wear and a lower sound level can be gained by selecting a higher pitched propeller. Here the engine can be propped out at the low end of the recommended maximum engine RPM range. Most engines burn less fuel per horsepower at this lower RPM end than at the higher RPM end of the recommended range. Here, again, the tachometer must be checked to be sure that with a maximum load the engine is not pulled below the bottom of the range, or "over-propping" occurs.

One reason for getting better fuel economy is that propellers tend to have a slight increase in efficiency as the pitch is increased within a given prop line.

SPORT BOATING

When a compromise between wide-open-throttle speed and acceleration is needed, propping out in the upper half of the recommended RPM range with a light load is suggested.

This should be the best prop, unless planing off with a heavy load is unsatisfactory, in which case dropping to the next lower pitch should solve the problem. But, again, it is important to watch top RPM.

BASS BOATING

Bass boats have become a very significant and very specialized breed. Designed to fit the every need of the serious fisherman, these boats tend to be narrow for their length, making them more difficult to plane off. This problem is further complicated by the considerable convenience equipment carried and the weight of one or 2 filled live wells on the trip home. The result is that careful propping at the top of the RPM range is essential for best over-all performance.

FISHING

Three-bladed props are smoother and perform better when the boat is carrying a larger load. If the slowest possible trolling speed is important, a very low pitch prop should be chosen.

Because of frequent operation in shallows, fishing props often become nicked. Better performance can be maintained if rough edges are kept filed. As a frequently filed prop becomes smaller, it eventually will struggle to plane off the boat, indicating time for a replacement.

WORK BOATS

This specialized class of boats - such as pontoon boats, and houseboats - use larger diameter, low pitch, lower rake propellers with large blade surface areas. Here durability generally is more significant than top speed.

With lower water velocity, it is important to keep the propeller low in the water to avoid ventilation of surface air around the anti-ventilation (anti-cavitation) plate via little whirlpools. I is imperative here to run the highest possible pitch that will satisfy all engine and usage requirements, since the basic efficiency of low pitch props is steadily dropping off as the pitch/diameter ratio declines.

What Is Cavitation?

Water boils at 212°F (100°C) at normal sea level atmospheric pressure. But water also boils at room temperature, if the atmospheric pressure is low enough.

As a shape passes through water at an increasing speed, the pressure, that holds the water to the sides and back of the shape, is lowered. Depending upon the water temperature, when the pressure reaches a sufficient low level, boiling will begin. This occurs most often on a propeller at the leading edge of the blade. When speed is reduced, and the pressure goes up, boiling will subside. As the water vapor bubbles move downstream into a higher pressure region that won't sustain boiling, they collapse (condense back to liquid). The collapsing action of the bubbles releases energy that chips away at the blades, causing a "cavitation burn" or erosion of the metal. (Figure 12)

The initial cause of the low pressure may be nicks in the leading edge, too much cup, sharp leading edge corners, improper polishing or sometimes poor blade design. Massive cavitation by itself is rare, and it usually is caused by a prop that is severely bent or far too small in diameter for the engine.

CAUSES of CAVITATION

1. A bent blade particularly at the leading edge.
2. Blade leading edges that have very square corners (round is best).
3. Too much cup.
4. Too small a propeller diameter for the engine size.
5. Increasing the gear reduction on an engine may raise the torque at the prop so high that the prop diameter becomes effectively too small.
6. Ventilation.

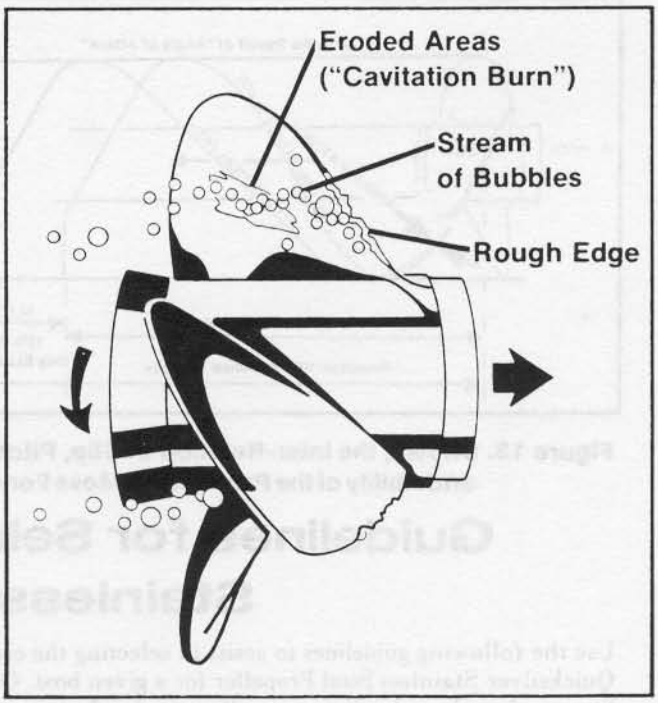


Figure 12. Cavitation Burn

What Is Ventilation?

Ventilation occurs when air from the water's surface or exhaust gases from the exhaust outlet are drawn into the propeller blades. The normal water load is reduced and the prop over-revs, losing much of its thrust; however, as the propeller momentarily over-revs, this brings on massive cavitation which can further "unload" the prop and kill all forward thrust. It continues until the prop is slowed down enough to allow the bubbles to surface. Ventilation most often occurs in turns, particularly when trying to plane in a sharp turn or with an excessive outward drive unit tilt.

CAUSES of VENTILATION

1. Running with the engine too high on the transom (prop is pulling in surface air).
2. Running with the engine trimmed out or up too far (prop is again pulling in surface air plus running at a less efficient angle through the water).
3. A missing or broken prop diffuser ring that can allow exhaust gas to be pulled back into the negative pressure or back side of blades, particularly while planing off or in turns.
4. Broken outer prop hub adjacent to the gearcase or a broken gearcase adjacent to the prop, either of which could allow exhaust gases to get directly into the prop blades.

What Is Slip?

"Slip" is the most misunderstood of all propeller terms, probably because the name sounds like something undesirable. The presence of slip does not necessarily mean propeller inefficiency. Slip is essential for a propeller to produce thrust -- to move a boat forward in the water; therefore, slip itself, is not bad. Too little or too much slip, however, makes for a less efficient propeller push than the right amount of slip. Slip is the percentage of the designated pitch that the prop does NOT successfully travel in one revolution.

HOW MUCH SLIP IS the "RIGHT AMOUNT"?

For typical planing pleasure boats, the most efficient amount of slip is in the area of 10% to 15%. With a well-selected propeller for a high-performance lightly-loaded boat, slip should remain around 10%. On a heavily-loaded, slower planing boat, proper slip increases to about 20% or 25%. A prop, that operates at zero slip, produces zero thrust, and zero slip will occur only when the propeller is windmilling while being towed or under rapid deceleration. Slip, in general, can be considered a measure of the load on the propeller. However, when slip rises to a critical point, the propeller will begin to cavitate.

WHAT CAUSES TOO MUCH or TOO LITTLE SLIP?

Too much slip will occur when the propeller diameter is too small for the engine and the boat load. It also can take place

when too much cavitation or ventilation begins to affect the propeller. These conditions have the effect of reducing the blade area in contact with the water. Too little slip occurs when the propeller diameter is too large for an engine/boat combination.

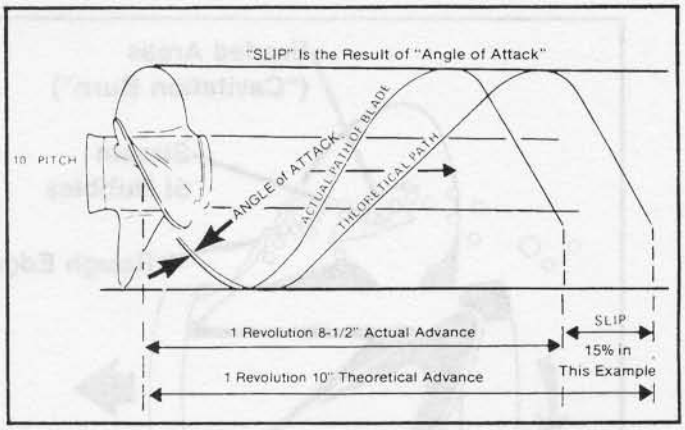


Figure 13. Shown, the Inter-Relation of Slip, Pitch and Ability of the Propeller to Move Forward

CORRECTIONS to HELP LOWER EXCESSIVE SLIP

1. Trim engine down or under a little.
2. If an older, uncupped prop is being used, either change to a newer, cupped prop or have the old one cupped.
3. If an older, lower rake prop is being used, switch to a newer, high rake stainless steel prop.
4. Check for a bent prop that could be causing extensive cavitation.
5. If prop is already cupped, have more cup added.
6. Check for a broken or missing prop diffuser ring.
7. Check for a broken outer prop hub adjacent to the gear housing or a broken gear housing adjacent to the prop, either of which could allow exhaust gases to get directly into the prop blades.
8. Lower the engine.
9. Check that prop diameter has not been significantly worn down.

A "Propeller Slip Calculator" (C-90-86147) is available thru Mercury Marine Publications Department.

Guidelines for Selection of Best Quicksilver Stainless Steel Propellers

Use the following guidelines to assist in selecting the correct Quicksilver Stainless Steel Propeller for a given boat. Guidelines are based on aluminum propeller which is known to provide best performance for that boat. Below is a chart to help determine whether an aluminum prop on a particular boat is considered large or small.

Large		Small	
Diameter	Pitch	Diameter	Pitch
14-1/2"	25"	13-1/4"	25"
15"	23"	13-1/2"	23"
15-1/4"	21"	13-1/4"	21"
15-1/2"	19"	14"	19"
15-3/4"	17"	14-1/4"	17"
16"	15"	14-1/2"	15"
16"	13"		

METRIC CONVERSION: 1" (Inch) = 2.54cm (Centimeters)

CONVENTIONAL QUICKSILVER STAINLESS STEEL PROPELLER SELECTION

1. For drives with the larger diameter cupped aluminum propeller, when running at full throttle and drive in trimmed position:
   a. If engine is operating within upper 2/3 of the maximum recommended RPM range, select the MerCruiser Quicksilver Stainless Steel prop of the SAME pitch.
   b. If the engine is operating in the lower 1/3 of the maximum recommended RPM range, select the MerCruiser Quicksilver Stainless Steel Propeller 2" LOWER in pitch.
2. For drives equipped with smaller diameter cupped aluminum propellers, when running at full throttle and with engine or drive in trimmed position:
   a. If engine is operating within upper 2/3 of the maximum recommended RPM, select the MerCruiser Quicksilver Stainless Steel prop of the next lower pitch.
   b. If engine is operating in the lower 1/3 of the maximum recommended RPM range, select the MerCruiser Quicksilver Stainless Steel prop 4" LOWER in pitch.

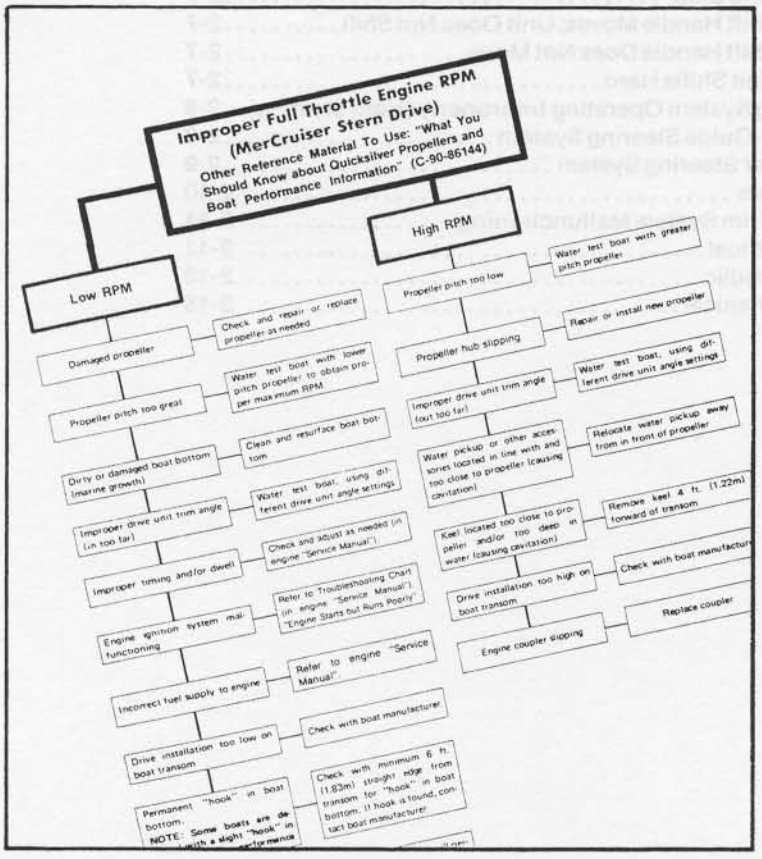
HI-PERFORMANCE (CLEAVER) PROPELLER SELECTION

1. For drives equipped with the larger diameter cupped aluminum propeller, when running at full throttle and with drive in trimmed position and, if:
   a. Stern drive is installed so that the anti-cavitation plate is above the bottom of the boat, and
   b. boat is capable of at least 50 MPH, and
   c. engine is operating within 200 RPM of the top end of the maximum recommended RPM range at full throttle, then . . .
   d. select the MerCruiser Quicksilver Stainless Steel (Cleaver) prop of the same pitch.
2. For drives equipped with the smaller diameter cupped aluminum propeller, when running at full throttle and with drive in trimmed position and, if all the above conditions in Step 1 apply, then select the MerCruiser Quicksilver Stainless Steel (Cleaver) prop of the next LOWER pitch.

I-DRIVE

Troubleshooting

SECTION 2



INDEX

	Page
Improper Full Throttle Engine RPM	2-1
Poor Boat Performance and/or Poor Maneuverability	2-2
Stern Drive Unit Noise	2-3
Noise in Gear Housing	2-3
Noise in Drive Shaft Housing	2-3
Stern Drive Unit Will Not Slide into Bell Housing	2-4
Shift System Malfunctions	2-5
Manual Shift	2-5
Shift Handle Moves; Unit Does Not Shift	2-5
Shift Handle Does Not Move	2-5
Unit Shifts Hard	2-6
Unit Jumps Out of Gear	2-6
Electric Shift	2-7
Shift Handle Moves; Unit Does Not Shift	2-7
Shift Handle Does Not Move	2-7
Unit Shifts Hard	2-7
Steering System Operating Improperly (Hard Steering)	2-8
Ride-Guide Steering System	2-8
Power Steering System	2-9
Others	2-10
Power Trim System Malfunctioning	2-11
Electrical	2-11
Hydraulic	2-13
Mechanical	2-15

Improper Full Throttle Engine RPM (MerCruiser Stern Drive)

Other Reference Material To Use: "What You Should Know about Quicksilver Propellers and Boat Performance Information" (C-90-86144)

Low RPM

Damaged propeller	Check and repair or replace propeller as needed
Propeller pitch too great	Water test boat with lower pitch propeller to obtain proper maximum RPM
Dirty or damaged boat bottom (marine growth)	Clean and resurface boat bottom
Improper drive unit trim angle (in too far)	Water test boat, using different drive unit angle settings
Improper timing and/or dwell	Check and adjust as needed (in engine "Service Manual")
Engine ignition system malfunctioning	Refer to Troubleshooting Chart (in engine "Service Manual"), "Engine Starts but Runs Poorly"
Incorrect fuel supply to engine	Refer to engine "Service Manual".
Drive installation too low on boat transom	Check with boat manufacturer
Permanent "hook" in boat bottom. **NOTE: Some boats are designed with a slight "hook" in boat for correct performance**	Check with minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If hook is found, contact boat manufacturer
"Power hook" in boat bottom (develops "hook" under power only; weak boat bottom)	Water test boat. Boat will perform normal until "hook" develops at high speed, then loss of RPM and speed will occur

High RPM

Propeller pitch too low	Water test boat with greater pitch propeller
Propeller hub slipping	Repair or install new propeller
Improper drive unit trim angle (out too far)	Water test boat, using different drive unit angle settings
Water pickup or other accessories located in line with and too close to propeller (causing cavitation)	Relocate water pickup away from in front of propeller
Keel located too close to propeller and/or too deep in water (causing cavitation)	Remove keel 4 ft. (1.22m) forward of transom
Drive installation too high on boat transom	Check with boat manufacturer
Engine coupler slipping	Replace coupler

Poor Boat Performance and/or Poor Maneuverability (MerCruiser Stern Drive)

Other Reference Material To Use: "What You Should Know about Quicksilver Propellers and Boat Performance Information" (C-90-86144)

Bow Too Low

- Improper drive unit trim angle
  - Water test boat, using different drive unit angle settings
- Weight distribution (heavy in bow [front] of boat)
  - Relocate stored gear from bow (front) of boat to stern (rear) and water test boat. If bow overweight is caused by permanently installed fuel tank(s) etc, contact boat manufacturer
- Under-powered
  - Check horsepower-to-boat weight ratio. Refer to boat manufacturer
- Permanent "hook" in boat bottom.
  NOTE: Some boats are designed with a slight "hook" in boat bottom for correct performance
  - Check with minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If hook is found, contact boat manufacturer
- "Power hook" in boat bottom (develops "hook" under power only; weak boat bottom)
  - Water test boat. Boat will perform normal until "hook" develops at high speed, then loss of RPM and speed will occur

Bow Too High

- Improper drive unit trim angle
  - Water test boat, using different drive unit angle settings
- Propeller pitch too great (also low RPM)
  - Water test boat with lower pitch propeller to obtain proper maximum RPM
- Dirty boat bottom (marine growth)
  - Clean boat bottom and retest boat
- Poor running engine
  - Refer to Troubleshooting Chart (in engine "Service Manual"), "Engine Starts but Runs Poorly"
- Weight distribution (heavy in stern [rear] of boat)
  - Relocate stored gear from stern (rear) to bow (front) of boat and water test. If stern overweight is caused by permanently installed fuel tank(s) etc, contact boat manufacturer
- "Rocker" in boat bottom
  - Check with minimum 6 ft. (1.83m) straight edge from transom for "rocker" in boat bottom. If "rocker" is found, contact boat manufacturer

Propeller Cavitating

- Drive unit installation too high on boat transom
  - Check with boat manufacturer
- Dirty or rough boat bottom (marine growth)
  - Clean and/or resurface boat bottom
- Damaged propeller
  - Repair or replace propeller as needed
- Keel located too close to propeller and/or too deep in water
  - Remove keel 4 ft. (1.22m) forward of transom
- Water pickup or other accessories located in line with and too close to propeller
  - Relocate water pickup away from in front of propeller
- Hook in bottom of boat
  - Check with minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If "hook" is found, contact boat manufacturer

Stern Drive Unit Noise

Noise in Gear Housing

Metal particles in drive unit lubricant	Disassemble drive unit, clean in solvent and dry with compressed air. Inspect gears and bearings (Section 3)
Propeller not correctly installed	Remove propeller and install correctly (Section 3B)
Propeller shaft bent	Replace propeller shaft (Section 3)
Gear alignment and/or shimming not correct	Check gear alignment and shimming. Repair as necessary (Section 3B)
Worn, damaged or loose parts in drive unit	Disassemble and inspect gears, bearings and shafts for wear, damage or loose fit (Section 3)

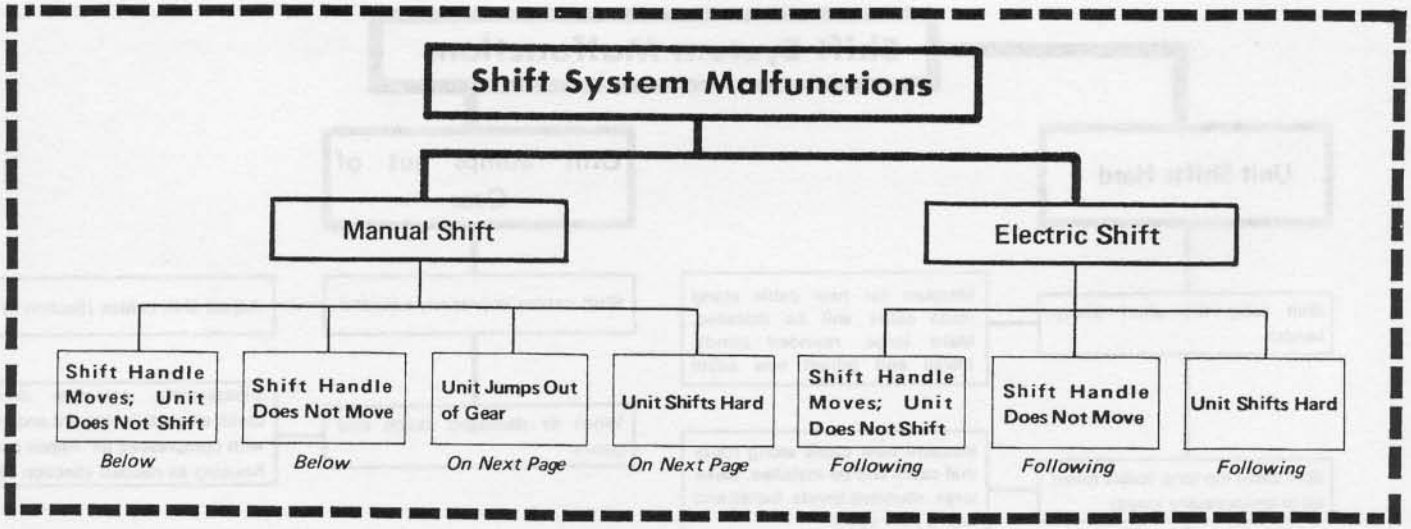
Noise in Drive Shaft Housing

Lubricant level low	Check lubricant level and add lubricant if necessary (Section 1)
Worn or dirty universal joint bearings	Check universal joint bearing and repair as necessary (Section 3A)
Worn or dirty gimbal bearing	Check bearing and repair as necessary (Section 4)
Metal particles in drive unit lubricant	Disassemble drive unit, clean in solvent and dry with compressed air. Inspect gears and bearings (Section 3)
Transom not thick enough	Check transom thickness. Shim transom plates if necessary
Gear alignment and/or shimming not correct	Check gear alignment and shimming. Repair as needed (Section 3A)
Worn, damaged or loose parts in drive unit	Disassemble and inspect gears, bearings and shafts for wear, damage or loose fit (Section 3)
Engine not aligned	Align engine with proper alignment tool (in engine "Service Manual")
Engine coupler worn	Replace engine coupler. Check engine alignment and lubricate coupler before drive installation (in engine "Service Manual")

Stern Drive Unit Will Not Slide into Bell Housing

MerCruiser I Drive

Universal joint shaft splines not aligned with engine coupling splines	**CAUTION: DO NOT rotate propeller shaft clockwise, or drive unit shift shaft will move out of forward gear position.** Rotate propeller shaft counterclockwise until drive unit can be pushed into position (Section 3B)
Drive unit not in forward gear	Place drive unit shift shaft in straight forward (forward gear) position. It may be necessary to rotate propeller shaft counterclockwise to obtain full forward position (Section 3B)
Shift shaft coupler in bell housing not aligned	Align shift shaft coupler in forward gear position (Section 3)
Engine not aligned	Align engine with proper alignment tool (in engine "Service Manual")
Bearing in gimbal housing not aligned	Align engine with proper alignment tool (in engine "Service Manual")
Damaged splines on shaft or coupling	Inspect splines and repair as needed (Section 3 and engine "Service Manual")


Shift System Malfunctions
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Unit Shifts Hard
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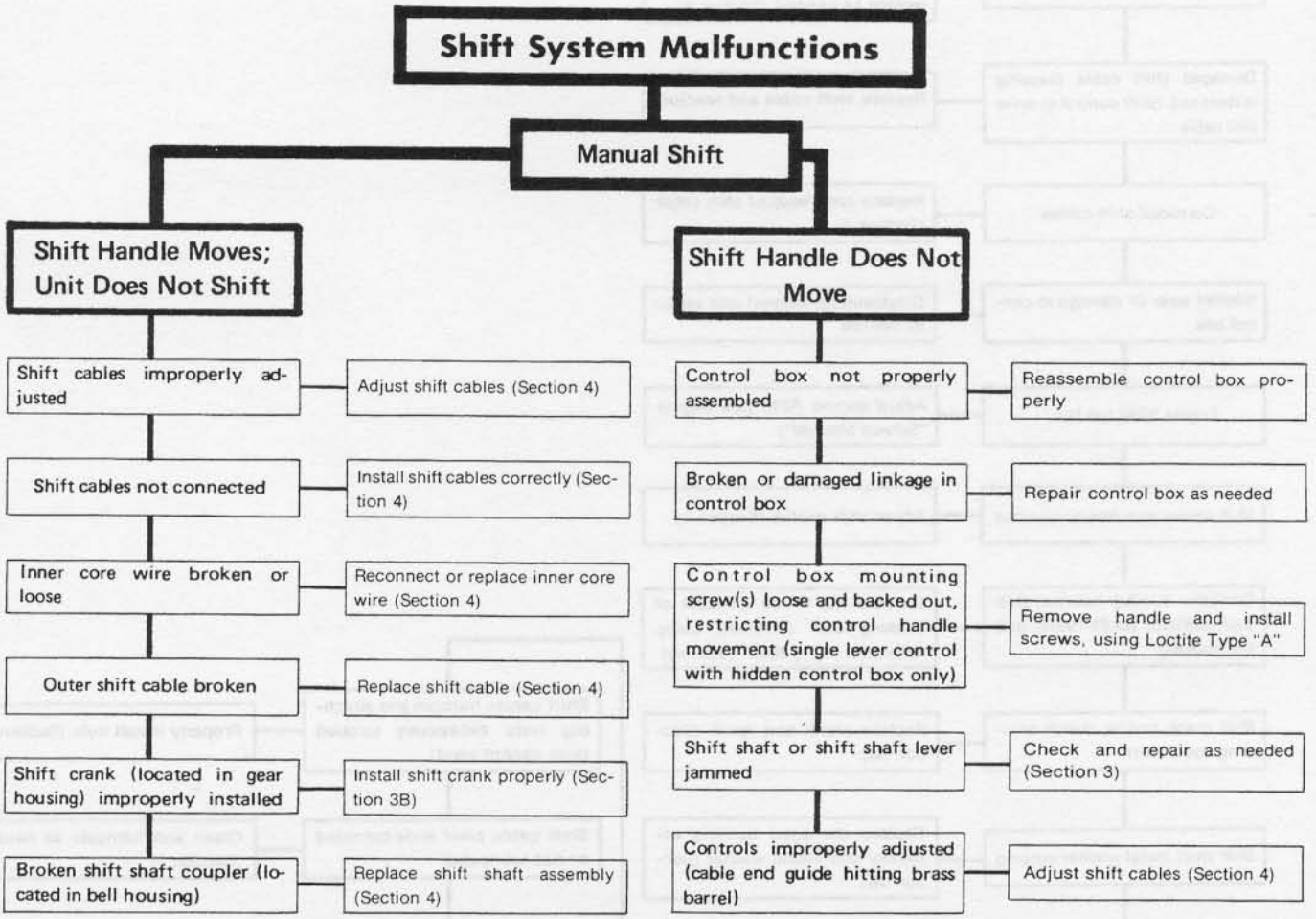
Shift System Malfunctions
Manual Shift
Shift Handle Moves; Unit Does Not Shift
Shift Handle Does Not Move
Shift cables improperly adjusted
Adjust shift cables (Section 4)
Shift cables not connected
Install shift cables correctly (Section 4)
Inner core wire broken or loose
Reconnect or replace inner core wire (Section 4)
Outer shift cable broken
Replace shift cable (Section 4)
Shift crank (located in gear housing) improperly installed
Install shift crank properly (Section 3B)
Broken shift shaft coupler (located in bell housing)
Replace shift shaft assembly (Section 4)
Control box not properly assembled
Reassemble control box properly
Broken or damaged linkage in control box
Repair control box as needed
Control box mounting screw(s) loose and backed out, restricting control handle movement (single lever control with hidden control box only)
Remove handle and install screws, using Loctite Type "A"
Shift shaft or shift shaft lever jammed
Check and repair as needed (Section 3)
Controls improperly adjusted (cable end guide hitting brass barrel)
Adjust shift cables (Section 4)

Shift System Malfunctions

Unit Shifts Hard

Shift cable too short (sharp bends)	Measure for new cable along route cable will be installed. Make large, rounded bends. Install and adjust new cable
Shift cable too long (cable rolled up or unnecessary loops)	Measure new cable along route that cable will be installed. Make large, rounded bends. Install and adjust new cable
Shift cutout switch inoperative	Test switch for continuity and proper adjustment. Adjust or replace as needed (Section 4)
Damaged shift cable (causing restriction). Shift control or drive unit cable	Replace shift cable and readjust
Corroded shift cables	Replace and readjust shift cable (Section 4)
Internal wear or damage in control box	Disassemble, inspect and repair as needed
Engine RPM too fast	Adjust engine RPM (see engine "Service Manual")
Shift cables improperly adjusted	Adjust shift cables (Section 4)
Corrosion buildup between shift shaft bushing (B-23-79372) and bell housing	Increase the inside diameter of bushing .007" (0.18mm), using letter drill "W" [.3860" (9.8mm)]
Shift crank and/or clutch actuating spool worn	Replace crank and spool (Section 3B)
Shift shaft metal washer missing	Replace damaged bushing assembly and install washer (Section 3B)
Bent shift shaft (3 shafts to check)	Replace bent shaft (Section 3 and/or 4)

Unit Jumps out of Gear

Shift cables improperly adjusted	Adjust shift cables (Section 4)
Worn or damaged clutch and gears	Disassemble complete drive, clean all parts in solvent and dry with compressed air. Repair gear housing as needed (Section 3B)
Shift cables transom end attaching nuts excessively torqued (end cannot pivot)	Properly install nuts (Section 4)
Shift cable pivot ends corroded or not lubricated	Clean and lubricate as needed (Section 1)
Shift cable secured too close to control box, not allowing cable housing movement	Remove clamp that secures cable closest to shift control box

Shift System Malfunctions

Electric Shift

Shift Handle Moves; Unit Does Not Shift

Shift control harness connections loose at electric shift motor	Tighten connections (see wiring diagram in engine "Service Manual")
Short or open in shift control harness	Test harness for shorts and opens
Control box switch(es) inoperative	Test control box switches
Electric shift motor inoperative	Repair shift motor as needed
Drive unit shift mechanism inoperative	Check and repair drive as needed (Sec. 3)
Electric shift motor not grounded	Check and repair connections as needed
Low battery voltage (engine not running)	Recharge or replace battery as needed
Shift link improperly adjusted	Adjust shift link

Shift Handle Does Not Move

Control box not properly assembled	Reassemble control properly
Broken or damaged linkage in control box	Repair control box as needed

Unit Shifts Hard

Internal damage in control box	Repair control as needed

Steering System Operating Improperly (Hard Steering)

- Ride-Guide Steering System — *Below*
- Power Steering System
  - Poor, Erratic or No Assist (Hard Steering with Engine Running)
    - This Part Covers Only Troubles Caused by Hydraulic Power Mechanism. Causes Related to "Ride-Guide System", Cables or "Others" Also Must Be Investigated — *On Next Page*
  - Noisy Pump — *On Next Page*
  - External Oil Leaks — *Following*
- Others — *Following*

Steering System Operating Improperly (Hard Steering)

Ride-Guide Steering System

Steering cable restriction, caused by damaged cable	Replace steering cable. Use correct length cable
Steering cable too short (sharp bends)	Measure for new cable along route cable will be installed. Make large, rounded bends. Install new cable of proper length
Steering cable too long (cable rolled up or unnecessary loops)	Measure for new cable along route cable will be installed. Make large, rounded bends. Install new cable of proper length
Steering cable corroded or lack of lubrication	Lubricate cable. If lubricant will not help badly corroded cable, replace cable assembly (Section 1)
Steering linkage nut(s) torqued too tight	Retorque nut(s) to specification
Rotary head attaching bolts installed from wrong side **NOTE: Super Rotary Ride-Guide only**	Remove bolts and install from correct side (see installation instructions)
Ride-Guide rack or rotary head not lubricated	Disassemble and grease

Steering System Operating Improperly (Hard Steering)

Poor, Erratic or No Assist (Hard Steering with Engine Running)

This Part Covers Only Troubles Caused by Hydraulic Power Mechanism. Causes Related to "Ride-Guide Steering System", Cables or "Others" Also Must Be Investigated

Loose drive belt	Adjust belt tension (Sec. 6)
Low oil level	Fill reservoir to proper level (Section 6)
Air in system	Locate source of air in oil return lines or fittings and correct. Also could be pump internal leak (Sec. 6)
Leaking hoses	Replace hoses
Defective pump	Test pump pressure. Replace pump, if necessary (Sec. 6)
Low oil pressure in steering cylinder caused by restriction in hoses	Check for kinks and foreign object in hoses. Replace hose, if necessary (Sec. 6)
Pressure loss in cylinder, caused by worn piston ring or scored housing bore	Test Power Steering system. Replace cylinder, if necessary (Sec. 6)
Loose fit of spool in valve body or leaky valve body	Test Power Steering system. Replace valve assembly, if necessary (Sec. 6)
Control valve not positioned properly	Adjust per installation instructions (Section 6)
Improper control valve balancing	Adjust control valve (Section 6)
Power Steering mounting bracket adjusting screw loose	Turn screw in until it bottoms out on inner transom plate, then tighten locknut (Section 6)
Flow control valve in pump sticking	Remove and inspect. (Sec. 6) Replace with new valve, if necessary

Power Steering System

Noisy Pump

Loose belt	Adjust belt tension (Sec. 6)
Low oil level	Fill reservoir (Sec. 6)
Air in oil	Locate source of air in oil return lines or fittings and correct. Also could be pump internal leak (Sec. 6)
Defective pump	Disassemble pump and check for scored parts, sticking vanes or improper installation of parts (Sec. 6)
Excessive back-pressure, caused by restriction in oil passages	Locate restriction and correct
Improper adjusted stop nuts	Check and adjust
Cables other than Ride-Guide being used that do not meet B.I.A. standards	Refer to Section 1
Power Steering mounting tube loose.	Tighten according to instructions in Section 6
Control valve mounting nut loose	Tighten (Sec. 6)

Steering System Operating Improperly

Power Steering System

External Oil Leaks

Loose hose connections	Tighten hose connections
Damaged hose	Replace hose
Oil leaking at top of reservoir (too full)	Remove oil down to proper level
Oil leaking at top of reservoir, caused by air or water in oil	Locate source of air or water and correct. Air also may enter system because of low reservoir oil level or internal pump leak. Test pump (Sec. 6)
Cylinder piston rod seal	Replace seals (Section 6)
Damaged or worn seals in valve	Replace seals (Section 6)
Cracked or porous metal parts	Locate and repair as needed
Bad pump seals and "O" rings	Refer to Section 6 for locations and replacement procedures

Others

Improper trim tab adjustment	Water test boat at speed and trim angle operator generally uses boat. Adjust trim tab as needed (Section 3)
Gimbal ring pivot roller bearings corroded or lack of lubrication	Lubricate bearings. If badly corroded bearings, replace bearings and seals (Section 4)

Power Trim System Malfunctioning

Electrical	Hydraulic (Following)	Mechanical (Following)
Will not trim up or out	Limit switch open or disconnected	Replace switch or reconnect (Sec. 4)
	Defective push button(s)	Replace defective part(s)
	Defective trim motor solenoid	Replace solenoid (Section 5)
	Defective trim motor field winding ("Up" circuit)	Test and replace if necessary (Sec. 5)
Will not tilt to full "Up" position	Trailering or "Up" button open circuit	Replace "Up" button
Will trim up or out with drive unit in reverse gear [*NOTE: New style reverse lock valve has a bypass valve to allow trim up (out) with drive unit in reverse gear*]	Improperly adjusted reverse lock valve (old style valve only)	Adjust according to procedure
	Cutout switch shorted (old style valve only)	Replace switch
Pump motor runs intermittently	Open or loose connections	Test and replace defective parts (Sec. 5)
	Open in armature	Replace armature (Section 5)
Pump motor runs only in "Down" direction	Defective push button(s)	Test and replace defective part(s)
	Limit switch open or disconnected or adjusted wrong	Replace switch or reconnect leads and adjust (Section 4)
	Solenoid inoperative	Replace solenoid (Section 5)
	Defective field winding ("Up" circuit)	Replace defective part (Section 5)
	High resistance, broken or loose connection(s) in "Up" circuit	Replace defective parts
Pump motor runs only in "Up" direction	Defective push button(s)	Test and replace defective part(s)

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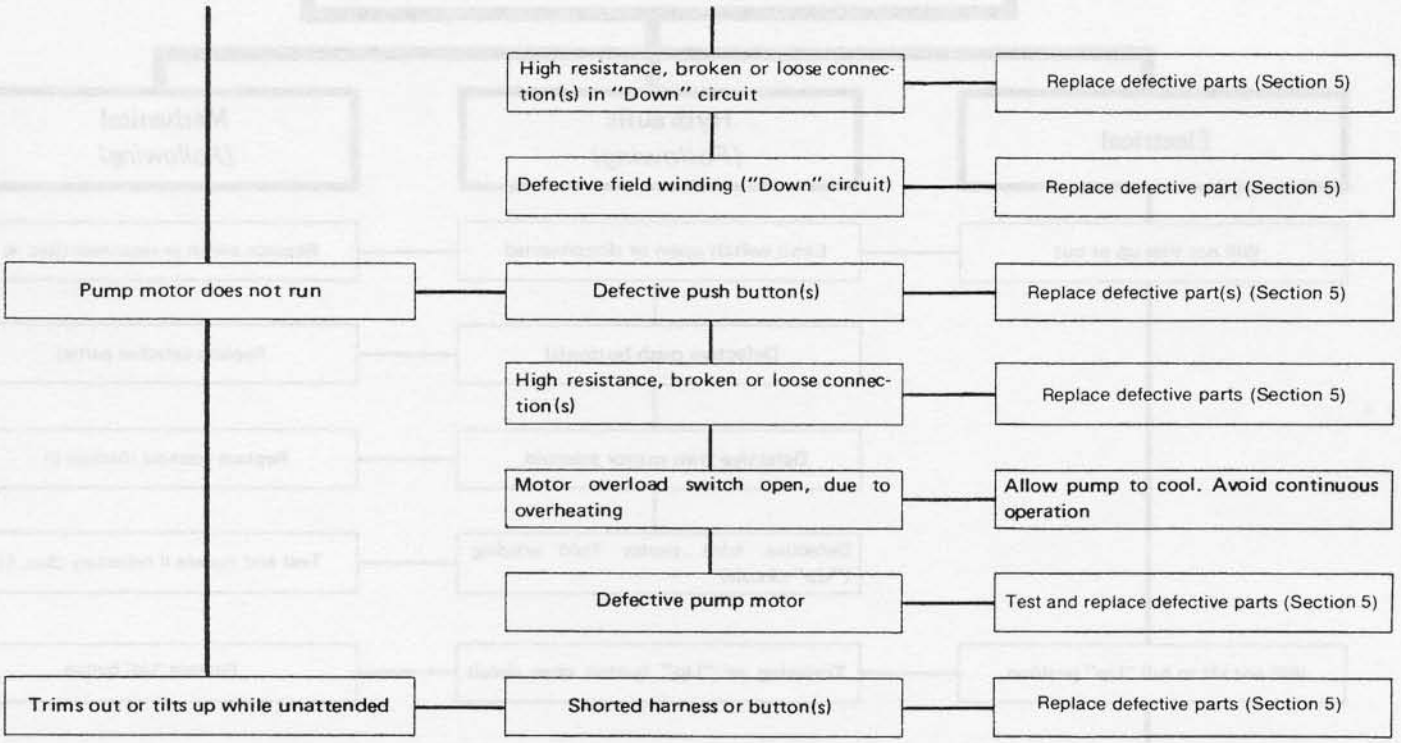

Power Trim System Malfunctioning

Hydraulic

Use Hydraulic Pump Test Gauge Assembly when troubleshooting Power Trim hydraulic system. Refer to Section 9 "Tools" for part number

Will not trim up or out	Oil level low	Add oil, bleed system and check for leaks (Section 5)
	Internal resistance in cylinders	Replace or repair cylinder(s) (Sec. 5)
	Too low or no pump pressure	Replace pump valve body assembly (Section 5)
Will not tilt to full "Up" position	Oil level low	Add oil and bleed system (Section 5)
	Internal resistance in cylinders	Replace or repair cylinder(s) (Section 5)
Will not release from full "Up" position	Valve body assembly inoperative	Replace valve body (Section 5)
	Internal resistance in cylinders	Replace or repair cylinder(s) (Section 5)
	Internal cylinder leak	Repair cylinder (Section 5)
Will not return completely to "Down" position or returns part way with jerky motion	Air in system	Check for leaks, fill reservoir and bleed system (Section 5)
	Internal cylinder(s) leaks	Replace or repair cylinder(s) (Section 5)
	Internal resistance in cylinders	Replace or repair cylinder(s) (Section 5)
	Hoses reversed on one cylinder only	Reinstall to proper connection (Section 5)

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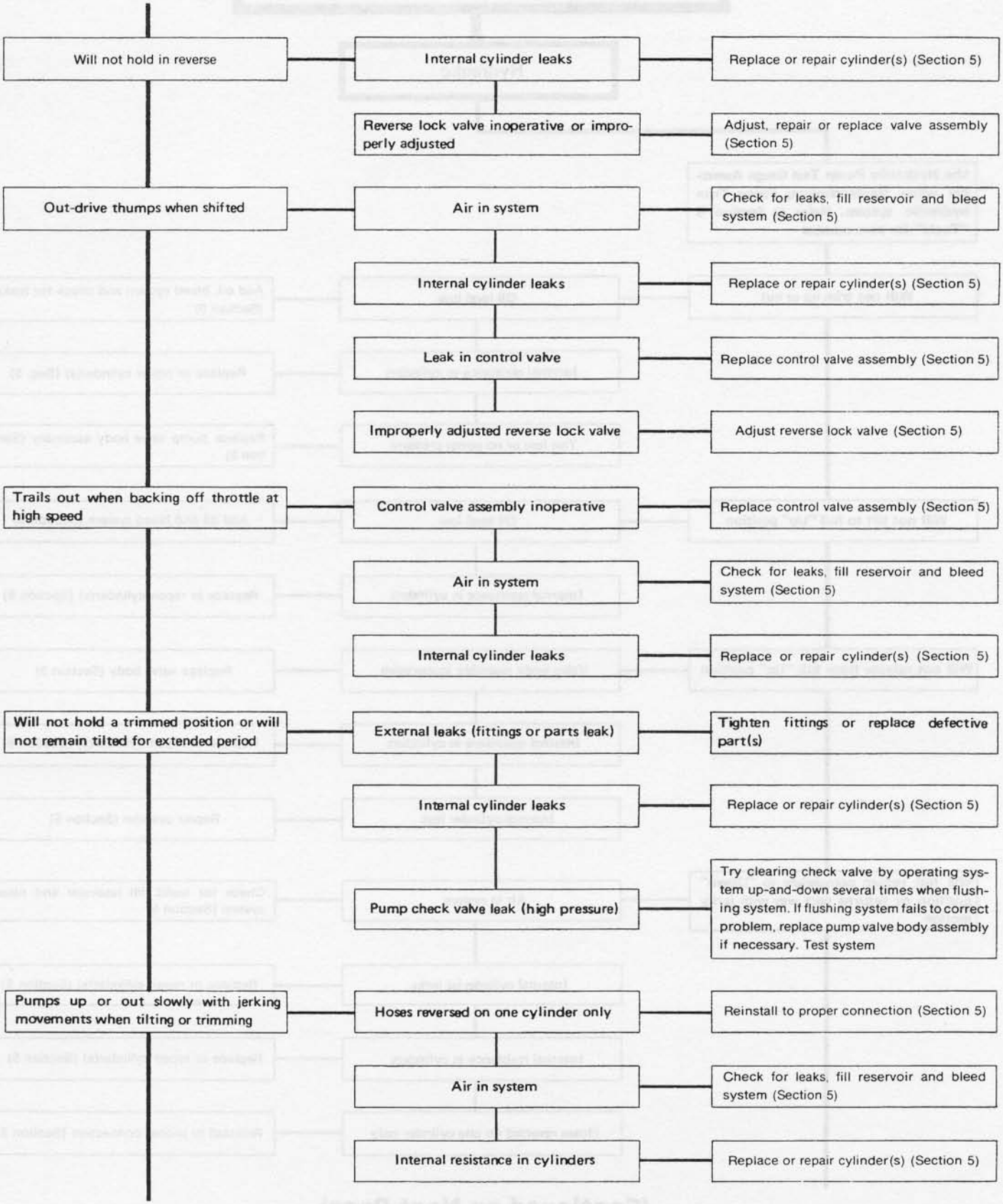

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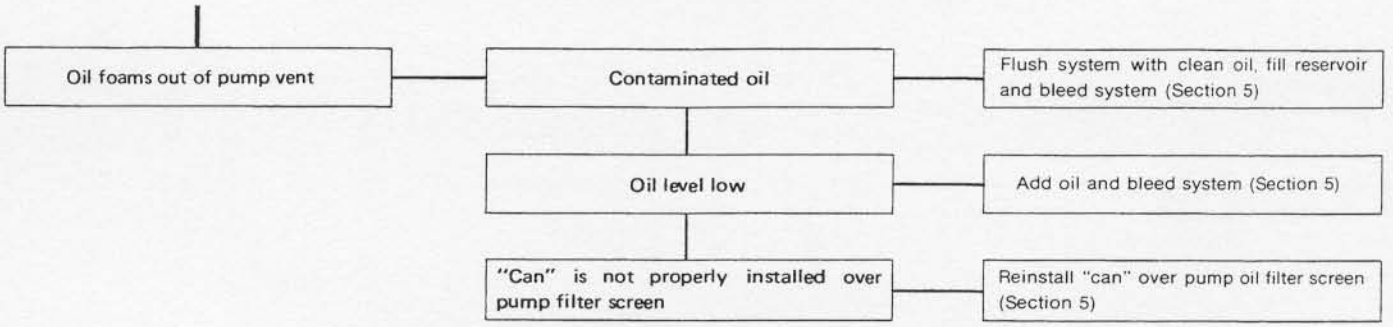
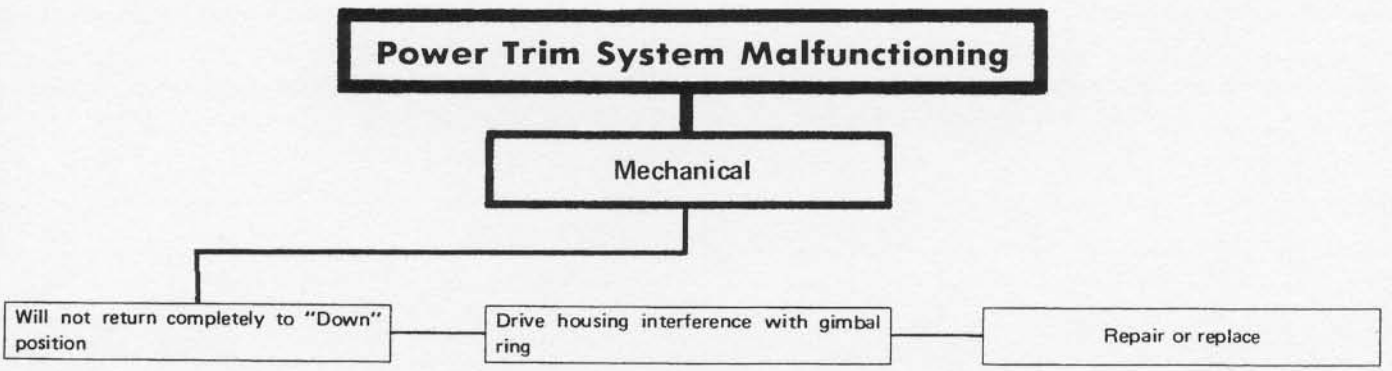
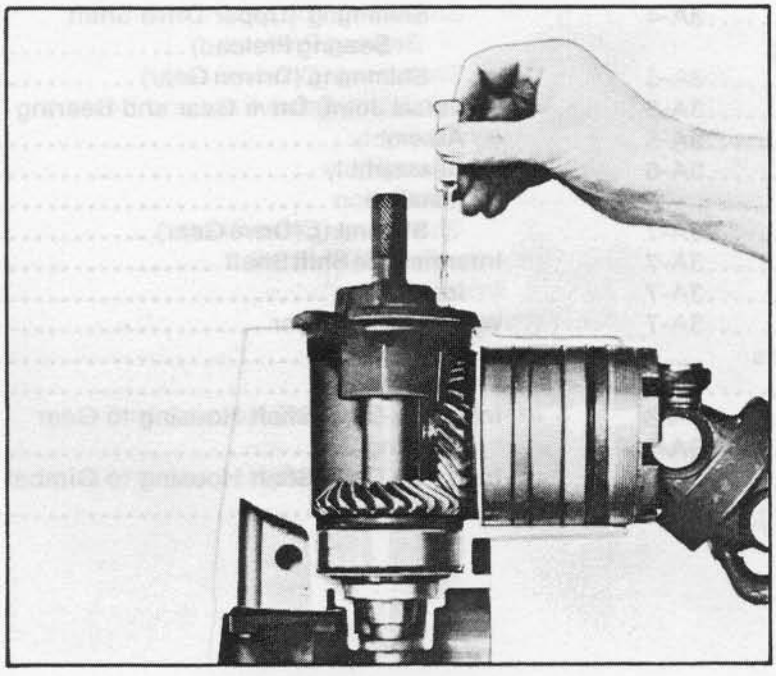




I-DRIVE

Drive Unit



SECTION 3

PART A

Drive Shaft Housing Assembly

INDEX

	Page
General Information	3A-1
Torque Specification Chart	3A-1
Special Service Tool Chart	3A-1
Drive Shaft Housing Removal and Disassembly	3A-2
Separating Drive Shaft Housing from Gear Housing	3A-2
Separating Drive Shaft Housing from Bell Housing	3A-3
Top Cover and Water Pocket Cover	3A-4
Removal	3A-4
Cleaning and Inspection	3A-4
Disassembly	3A-4
Universal Joint, Drive Gear and Bearing Assembly	3A-5
Removal	3A-5
Disassembly	3A-5
Cleaning and Inspection	3A-6
Upper Drive Shaft and Driven Gear Assembly	3A-7
Removal	3A-7
Cleaning and Inspection	3A-7
Disassembly	3A-7
Bearing Cup (Driven Gear) and Oil Seals and Intermediate Shift Shaft	3A-8
Cleaning and Inspection	3A-8
Removal	3A-8
Drive Shaft Housing Body	3A-9
Drive Shaft Housing Reassembly and Installation	3A-10
Driven Gear Bearing Cup	3A-10
Installation	3A-10
Upper Drive Shaft and Driven Gear Assembly	3A-10
Reassembly	3A-10
Installation	3A-11
Top Cover and Upper Drive Shaft Oil Seals	3A-11
Reassembly	3A-11
Installation	3A-12
Shimming (Upper Drive Shaft Bearing Preload)	3A-12
Shimming (Driven Gear)	3A-12
Universal Joint, Drive Gear and Bearing Assembly	3A-14
Reassembly	3A-14
Installation	3A-15
Shimming (Drive Gear)	3A-16
Intermediate Shift Shaft	3A-16
Installation	3A-16
Water Pocket Cover	3A-17
Reassembly	3A-17
Installation	3A-17
Installing Drive Shaft Housing to Gear Housing	3A-17
Installing Drive Shaft Housing to Gimbal Housing	3A-19

GENERAL INFORMATION

Torque specifications and special service tools, which are used in drive shaft housing assembly service procedures for the I-Drive, are listed in alphabetical order in the following charts:

Torque Specification Location	Thread	Ft. Lbs.
Bell Hsg. to Drive Shaft Hsg. Stud, Nut	7/16-20	50
Drive Shaft Hsg. to Gear Hsg. Stud, Nut	7/16-20	35
Drive Shaft Housing Top Cover, Screw	3/8-16	20
Trim Tab Bolt	----	180*
Universal Joint Shaft Bearing Retainer	3-7/8-16	200
Universal Joint Shaft Pinion, Nut	5/8-18	80
Upper Drive Shaft Preload	----	6-10*
Water Pocket Cover, Screw	1/4-20	30-40*

* *In. Lbs.* *(Metric: 1 Ft. Lb. = 0.14mkg; 1 In. Lb. = 1.15kg-cm)*

Part No.	Special Service Tool Description
C-91-38756	Adaptor
C-91-38918	Bearing Cup Driver
C-91-33493	Bearing Driver Cup
C-91-36235	Bearing Retainer Wrench
C-91-48247*	Engine Coupler Alignment Shaft
C-91-56032	Oil Seal Driver
C-91-60526	Shimming Tool (Upper Drive Gear)
C-91-60523	Shimming Tool (Upper Pinion)
C-91-34569A1	Slide Hammer Puller
C-91-66274	Torque Wrench (In. Lbs.)
C-91-37241	Universal Puller Plate

* *C-91-57797A3 Also Can Be Used*

1 - Button
2 - Drive Shaft Housing
3 - Water Pocket Cover
4 - Shims
5 - Bearing
6 - Driven Gear
7 - Drive Gear
8 - Shims
9 - Upper Drive Shaft
10 - Bearing
11 - Shims
12 - Top Cover
13 - Bearing Set
14 - Oil Seal Carrier
15 - Ring
16 - Retainer
17 - Universal Joint Assembly
18 - "O" Rings
19 - "O" Rings
20 - Spacer
21 - Oil Seals
22 - Shift Shaft
23 - Bushing
24 - Washer
25 - Cotter Pin
26 - Water Tube

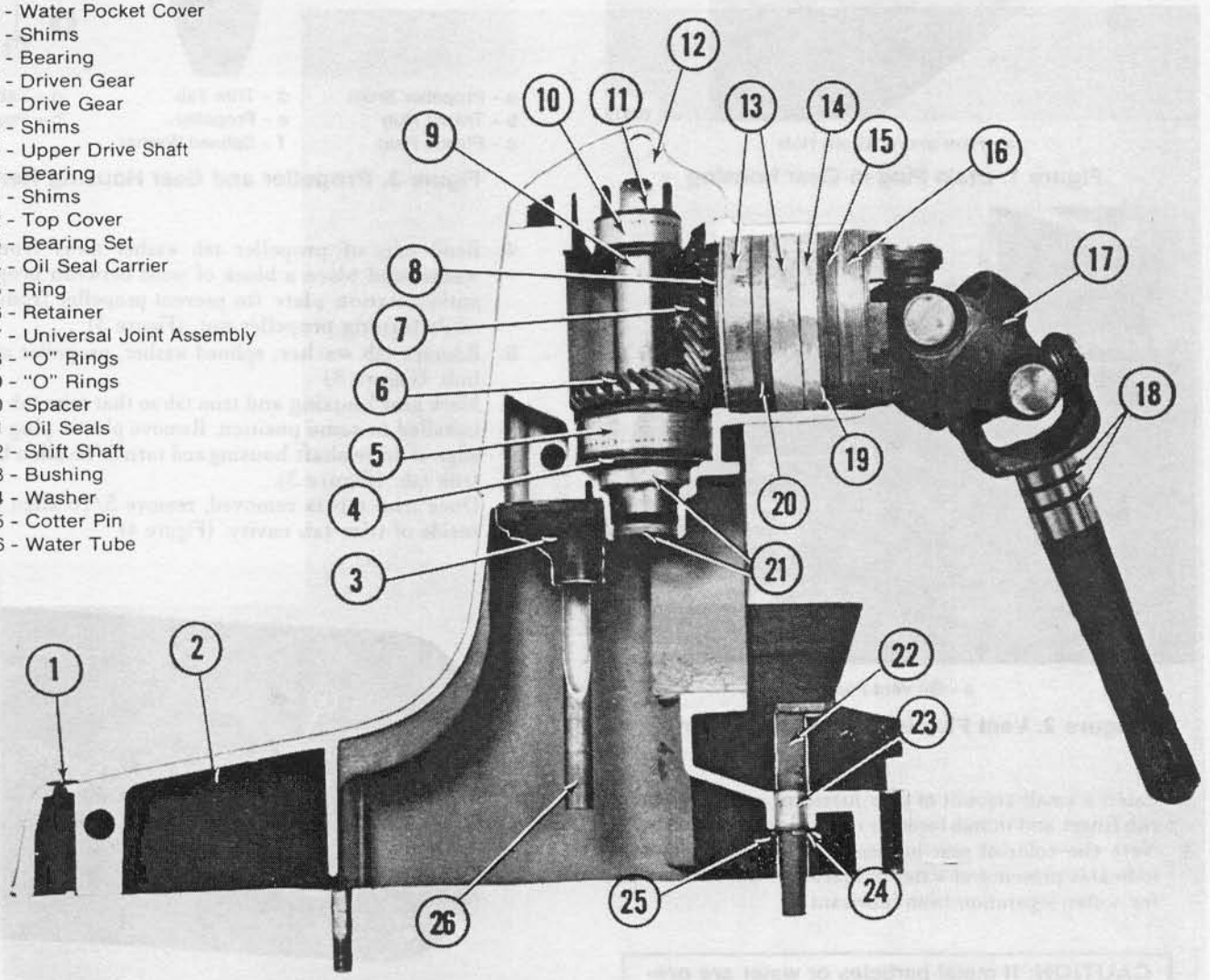
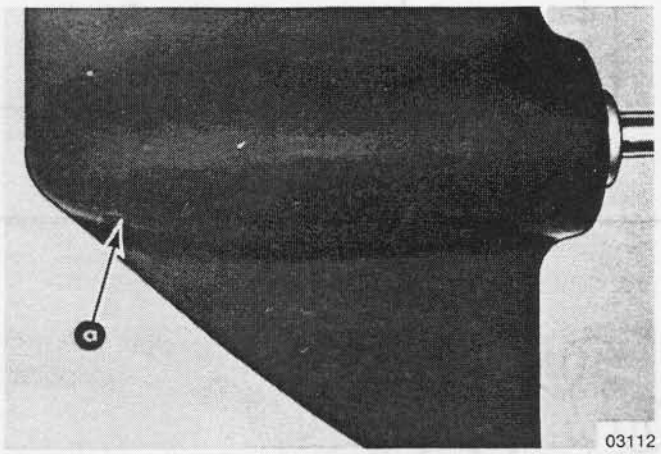


Figure A. Drive Shaft Housing Parts Identification

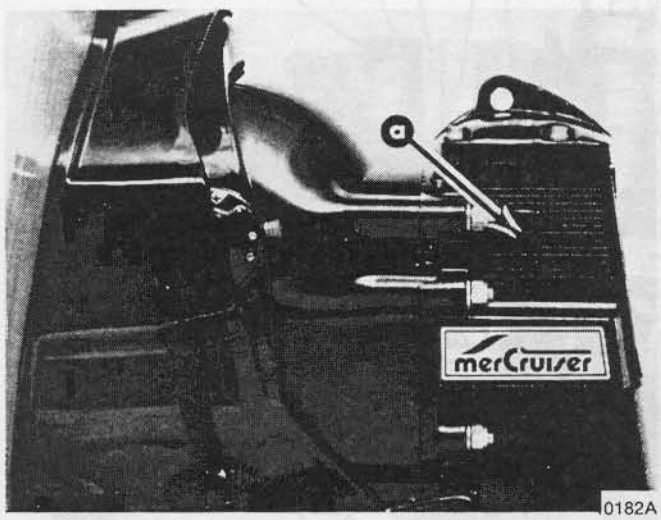
DRIVE SHAFT HOUSING
REMOVAL and DISASSEMBLY
Separating Drive Shaft Housing from Gear Housing

1. To drain lubricant, position drive unit so that propeller shaft is horizontal, then remove drain plug (Figure 1) and vent plug. (Figure 2)



a - Filler and/or Drain Hole

Figure 1. Drain Plug in Gear Housing

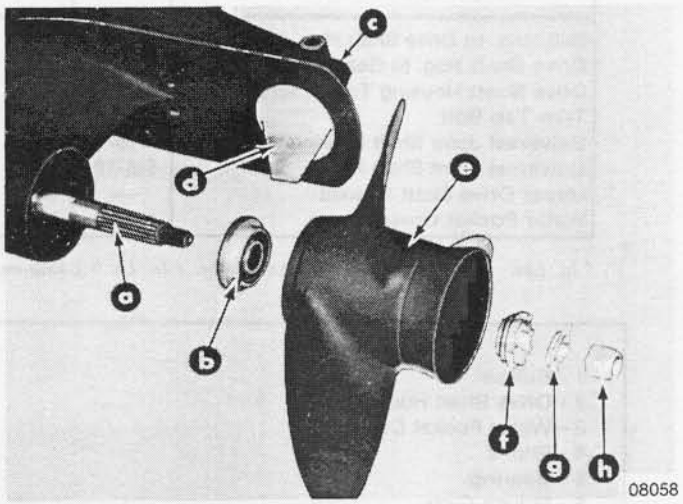


a - Oil Vent Plug

Figure 2. Vent Plug in Drive Shaft Housing

2. Catch a small amount of gear lubricant on a finger, then rub finger and thumb together to check for metal particles.
3. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant.

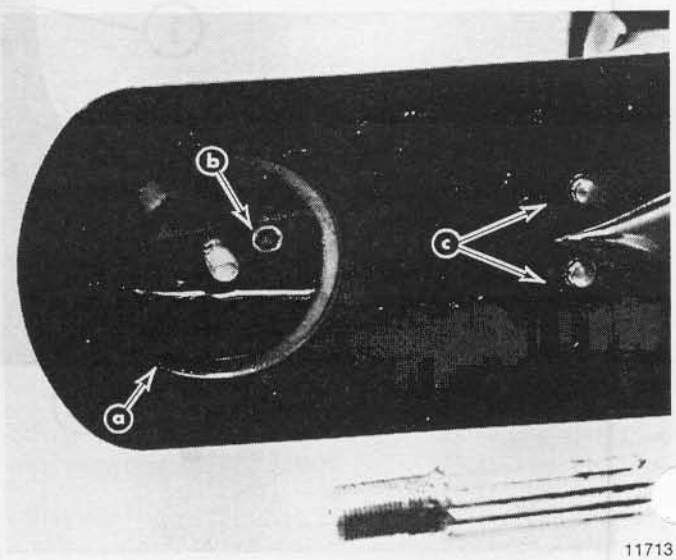
CAUTION: If metal particles or water are present in drive unit lubricant, both drive shaft housing and gear housing must be disassembled, cleaned in solvent and closely inspected for bad oil seals or seal surfaces, damaged "O" rings and/or cracks in gear housing.



a - Propeller Shaft
b - Thrust Hub
c - Plastic Plug
d - Trim Tab
e - Propeller
f - Splined Washer
g - Tab Washer
h - Propeller Nut

Figure 3. Propeller and Gear Housing Removal

4. Bend tabs of propeller tab washer away from spline washer and place a block of wood between propeller and anti-cavitation plate (to prevent propeller from turning) while turning propeller nut. (Figure 3)
5. Remove tab washer, splined washer, propeller and thrust hub. (Figure 3)
6. Mark gear housing and trim tab so that trim tab can be re-installed in same position. Remove plastic plug from rear edge of drive shaft housing and turn 5/16 allen bolt out of trim tab. (Figure 3)
7. Once trim tab is removed, remove 5/16 allen bolt from inside of trim tab cavity. (Figure 4)



a - Trim Tab Cavity b - Allen Screw c - Locknuts (Removed)

Figure 4. Allen Screw and Locknut Location

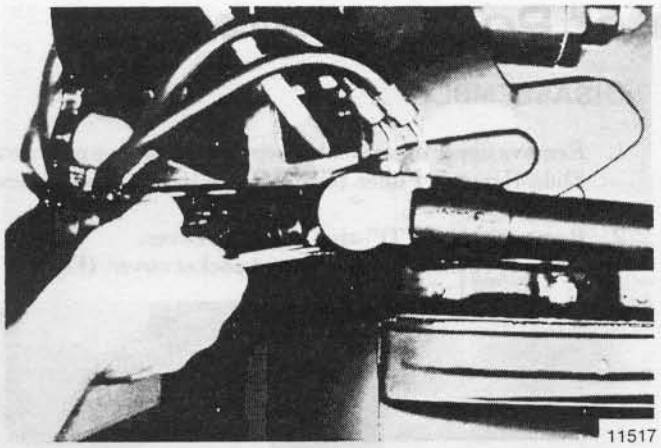
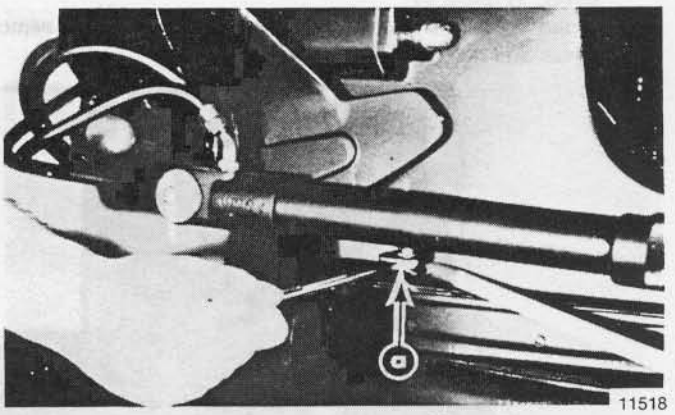


Figure 5. Removing Front Locknut

8. Remove 2 locknuts from bottom middle of anti-cavitation plate. (Figure 4)
9. Remove locknut from front of gear housing mounting stud. (Figure 5)
10. Loosen the side mounting locknuts (Figure 6) (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or drive shaft housing could be damaged.)
11. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 10) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it is now free.)



a - One Locknut Both Sides

Figure 6. Side Locknut Location

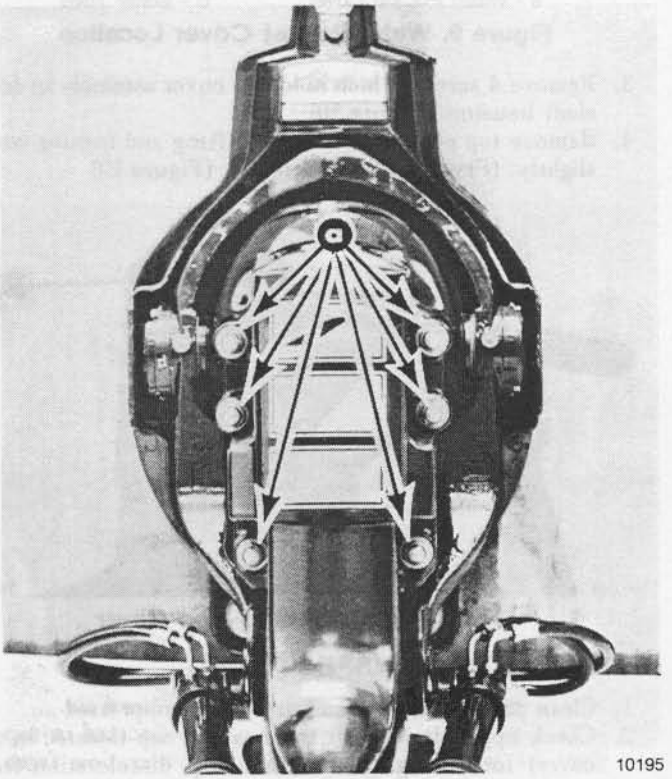
Separating Drive Shaft Housing from Bell Housing

1. Remove nuts and washers, which secure the aft end of Power Trim cylinders, and remove aft end of cylinders from drive shaft housing. (Figure 7) Retain rubber bushings, washers, spiral springs and continuity springs for reassembly.

   NOTE: It may be necessary to first loosen the trim cylinders' forward mounting nuts before removing the aft end of cylinders from drive shaft housing.

a - Trim Cylinder b - Forward Anchor Pin c - Aft Anchor Pin

Figure 7. Removing Trim Cylinders



a - Locknuts

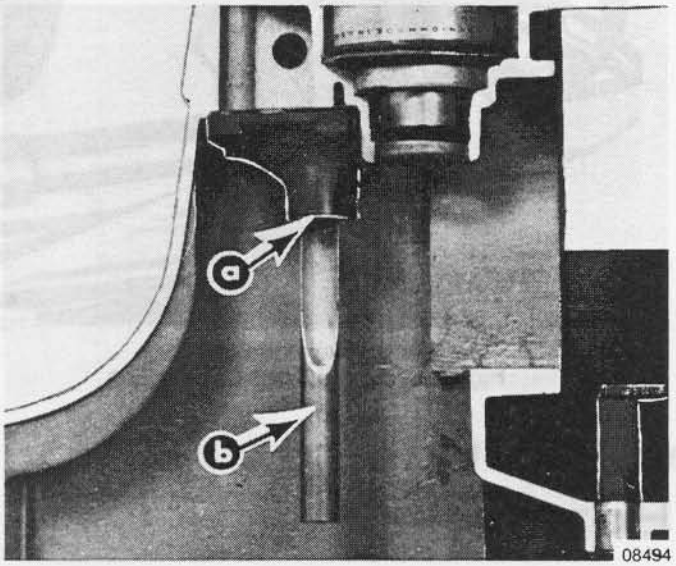
Figure 8. Removing Drive Unit

2. Remove 6 mounting nuts and washers from drive housing (Figure 8), then shift drive unit into forward gear so that shift shafts will separate.
3. Pull drive shaft housing from bell housing.
4. Remove drive shaft housing to bell housing gasket and rubber gasket and "O" ring from the bell housing assembly.

Top Cover and Water Pocket Cover

REMOVAL

1. Remove copper water tube, if it is still in water pocket cover. (Figure 9)
2. Remove screws from water pocket cover, then remove cover and gasket. (Figure 9)



a - Water Pocket Cover b - Water Tube

Figure 9. Water Pocket Cover Location

3. Remove 4 screws which hold top cover assembly to drive shaft housing. (Figure 10)
4. Remove top cover assembly by lifting and turning cover slightly. (Pry slots are provided.) (Figure 10)

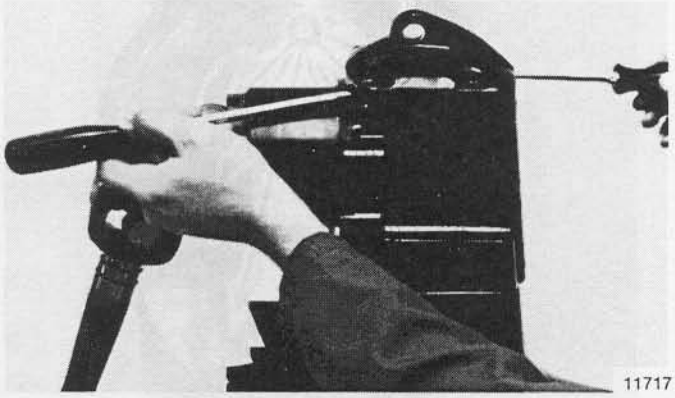


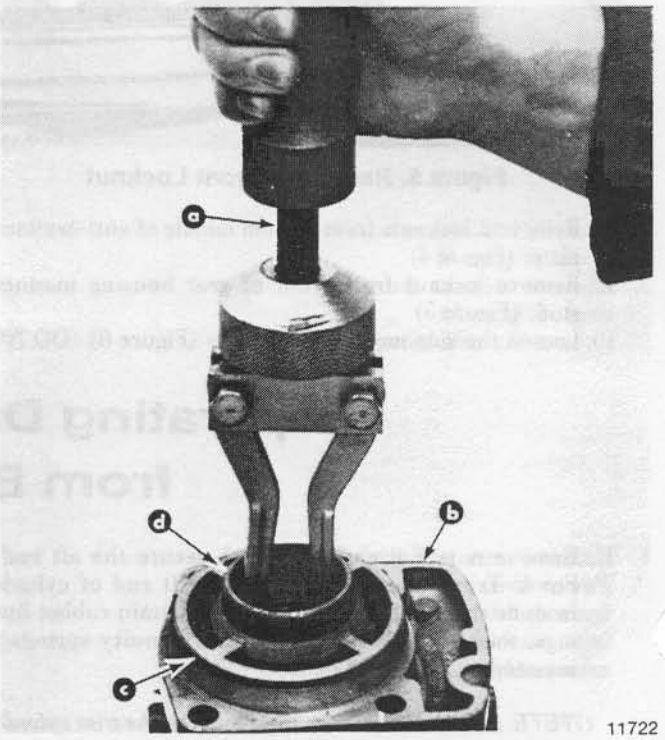
Figure 10. Removing Top Cover

CLEANING and INSPECTION

1. Clean parts in solvent and dry with compressed air.
2. Check upper drive shaft top bearing cup (located in top cover) for pitting, grooves, scoring, discoloration from overheating, uneven wear and embedded foreign metal particles. If any of these exist, replace bearing cup and bearing.
3. Inspect shim(s) to see if they were damaged during removal. If damaged, replace with shim(s) of same thickness.

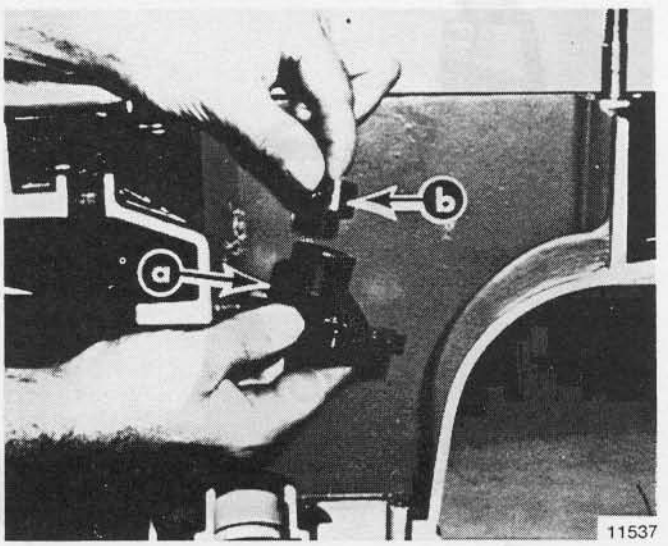
DISASSEMBLY

1. Remove upper drive shaft bearing cup from top cover with Slide Hammer Puller (C-91-34569A1) and 2-jawed head. (Figure 11)
2. Remove rubber "O" ring from top cover.
3. Remove rubber seal from water pocket cover. (Figure 12)



a - Slide Hammer c - Rubber "O" Ring
b - Top Cover d - Bearing Cup

Figure 11. Removing Bearing Cup from Top Cover



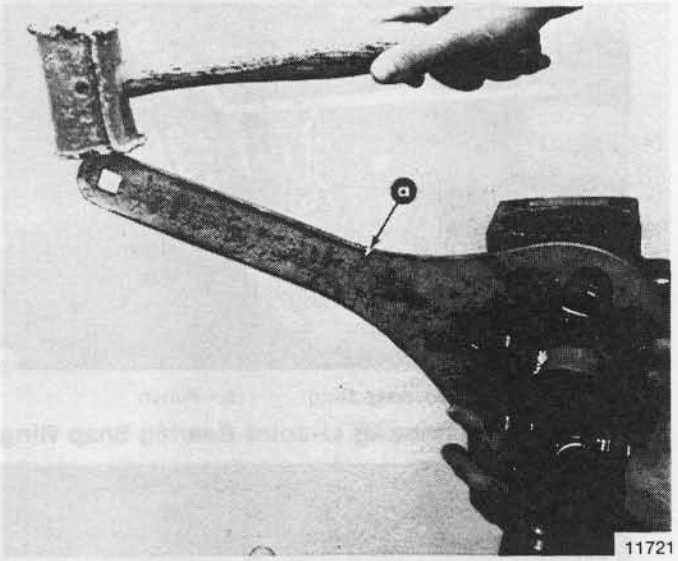
a - Water Pocket Cover b - Seal

Figure 12. Removing Seal from Water Pocket Cover

Universal Joint, Drive Gear and Bearing Assembly

REMOVAL

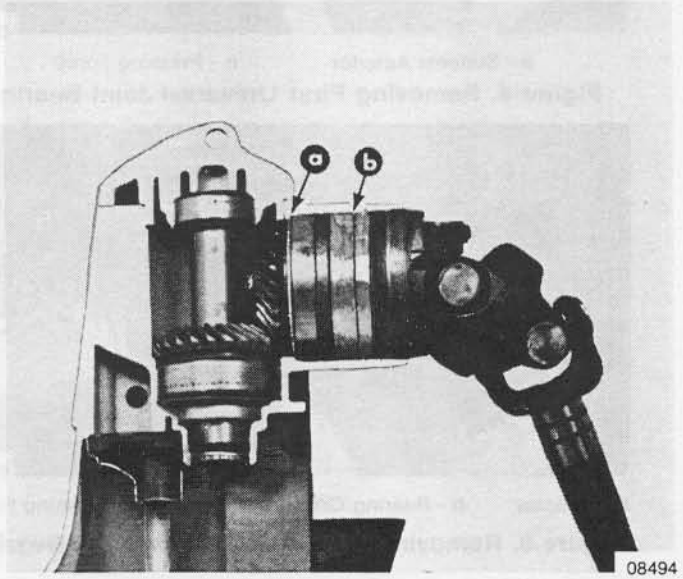
1. Loosen universal joint tapered roller bearing retainer by turning counterclockwise (looking from U-joint side) with Bearing Retainer Wrench (C-91-36235). (Figure 1)



a - Bearing Retainer Wrench (C-91-36235)

Figure 1. Removing Bearing Retainer

2. Pull straight out on universal joint to remove universal joint, drive gear and bearing assembly.
3. Remove shims and spacer which may adhere to bearing cup and/or shoulder in drive shaft housing. Retain shims and spacer for reassembly. (Figure 2)



a - Shim and Spacer Location
b - Drive Gear and Bearing Assembly

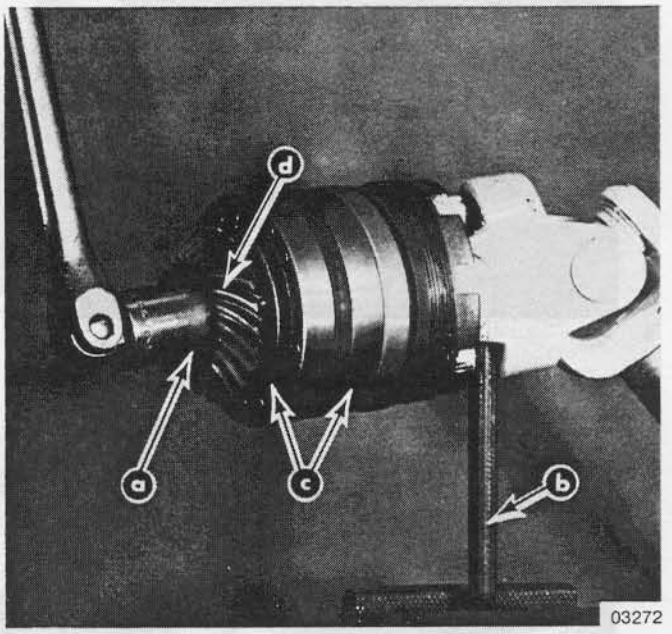
Figure 2. Drive Gear Shim Location

DISASSEMBLY

NOTE: Bearing assembly must be disassembled to obtain proper cleaning and inspection.

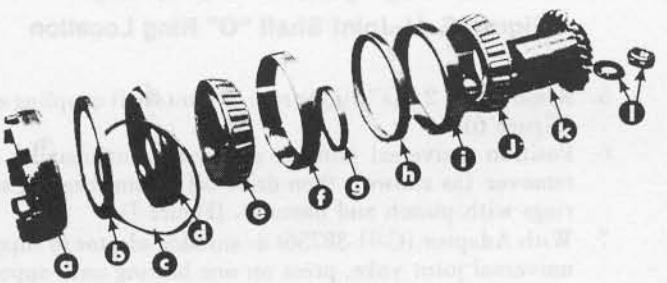
1. Place one end of suitable bar in vise and other end through universal joint yoke (for holding assembly) and remove nut. (Figure 3)
2. Remove drive gear and bearing assembly from U-joint shaft. (Figure 3)

CAUTION: DO NOT switch drive gear tapered roller bearings and cups. Bearing must stay with its original bearing cup. Bearings also should be installed on gear in same order as removed. If bearing replacement is necessary, both bearings and small and large spacers must be replaced as an assembly to ensure correct amount of preload when reassembled.



a - Drive Gear Nut (Hidden)
b - Bar to Hold U-Joint
c - Bearing Assembly
d - Drive Gear

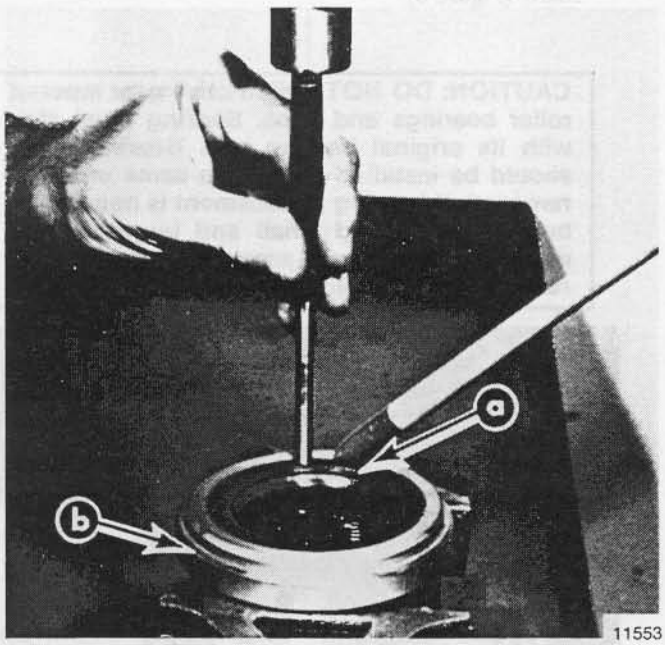
Figure 3. Drive Gear and Bearing Disassembly



a - Retainer
b - Retainer Ring
c - "O" Ring
d - Oil Seal Carrier
e - Tapered Bearing
f - Bearing Cup
g - Preload Spacer
h - Outer Spacer
i - Second Bearing Cup
j - Tapered Bearing
k - Drive Gear
l - Washer and Nut

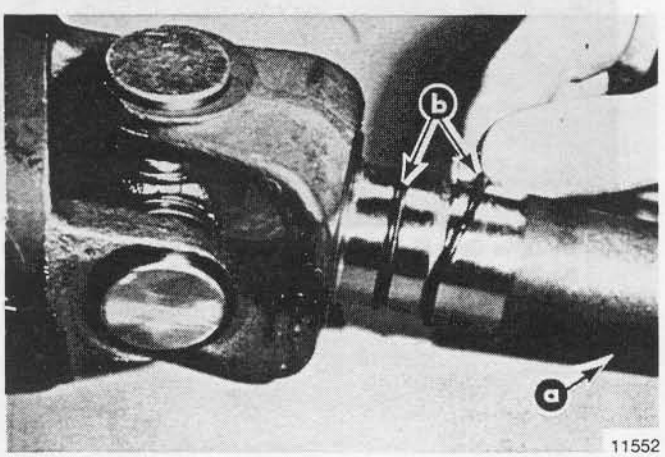
Figure 4. Drive Gear and Bearing Assembly

3. Separate bearing assembly into its components: Threaded retainer, retainer ring, "O" ring, oil seal with oil seal carrier, tapered roller bearing, bearing cup, preload spacer, outer spacer, second bearing cup with tapered roller bearing, drive gear, washer and nut. (Figure 4)
4. Remove universal joint oil seal from oil seal carrier. (Figure 5)



a - Oil Seal b - Oil Seal Carrier

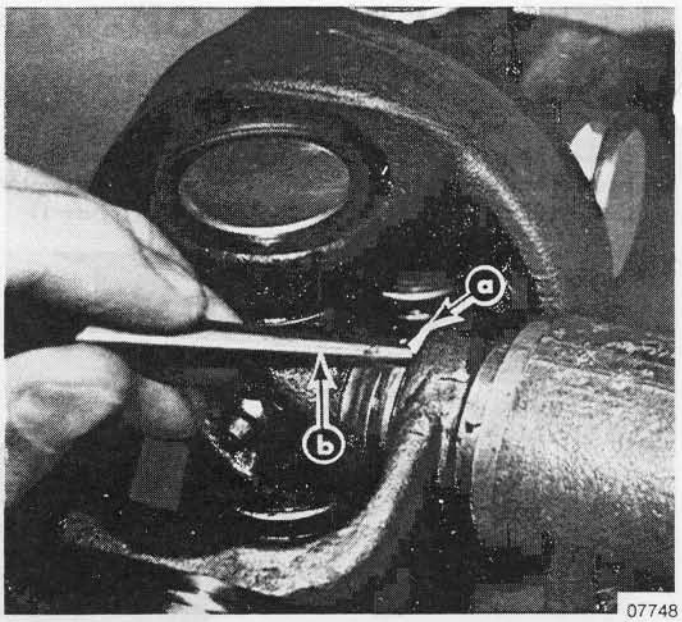
Figure 5. Removing Oil Seal from Carrier



a - Coupling End b - "O" Ring

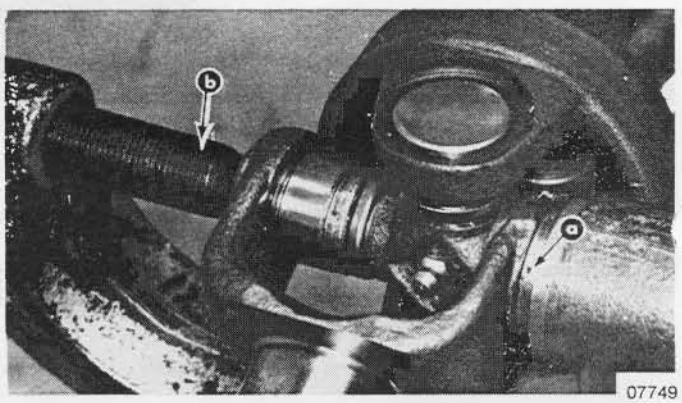
Figure 6. U-Joint Shaft "O" Ring Location

5. Remove the 2 "O" rings from U-joint shaft coupling end. (Figure 6)
6. Position universal joint in universal joint installer and remover (as shown), then drive off U-joint bearing snap rings with punch and hammer. (Figure 7)
7. With Adaptor (C-91-38756) or suitable adaptor to support universal joint yoke, press on one bearing until opposite bearing is pressed into adaptor, then remove the one free bearing. (Figure 8)
8. Turn universal joint assembly 180° and press on bearing cross-member to remove opposite bearing. Repeat this procedure for removing remaining U-joint bearings.



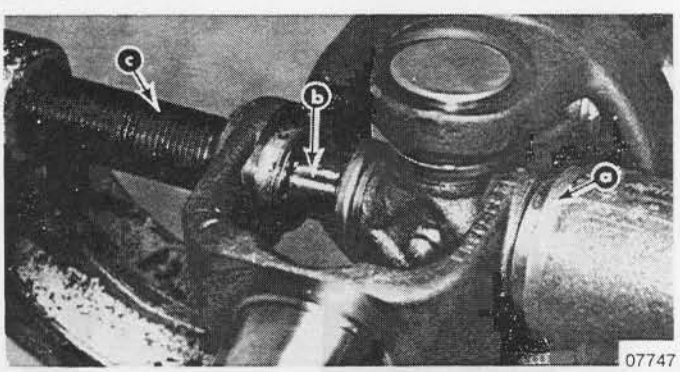
a - Snap Ring b - Punch

Figure 7. Removing U-Joint Bearing Snap Rings



a - Suitable Adaptor b - Pressing Force

Figure 8. Removing First Universal Joint Bearing



a - Adaptor b - Bearing Cross-Member c - Pressing Force

Figure 9. Removing Second Universal Joint Bearing

CLEANING and INSPECTION

1. Clean all parts in solvent and dry with compressed air.

CAUTION: DO NOT spin bearing dry with compressed air, as this could cause bearing to score.

2. Inspect splines on both coupling and gear end of universal joint assembly for wear.
3. Clean all corrosion from coupling end. If splines are partially corroded away, replace (coupling end) yoke.

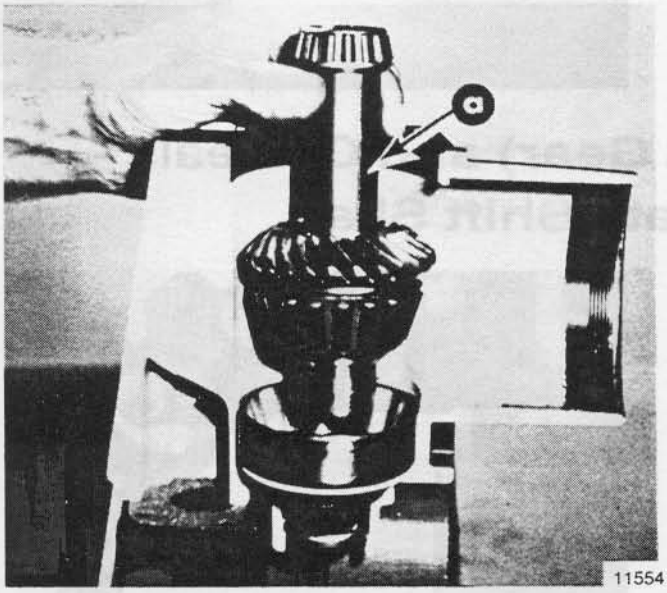
   NOTE: If U-joint coupling end splines are corroded or worn, also inspect engine coupling splines.

4. Inspect small shaft between yoke and splines for groove where oil seal rides. If shaft is grooved, install NEW yoke on universal joint.
5. Check U-joint bearings for excess looseness.
6. Inspect drive gear for pitting, chipped or broken teeth and excessive or uneven wear. Replace gear if any of these exist.
7. Check tapered roller bearings by inspecting bearing cups. Replace bearings and bearing cups, if cups are pitted, grooved, scored, worn uneven or discolored from overheating.
8. Replace all damaged shims with new shims of same thickness.

Upper Drive Shaft and Driven Gear Assembly

REMOVAL

Lift upper drive shaft and gear assembly from drive shaft housing. (Figure 10)



a - Upper Drive Shaft and Gear Assembly

Figure 10. Removing Drive Shaft and Gear Assembly

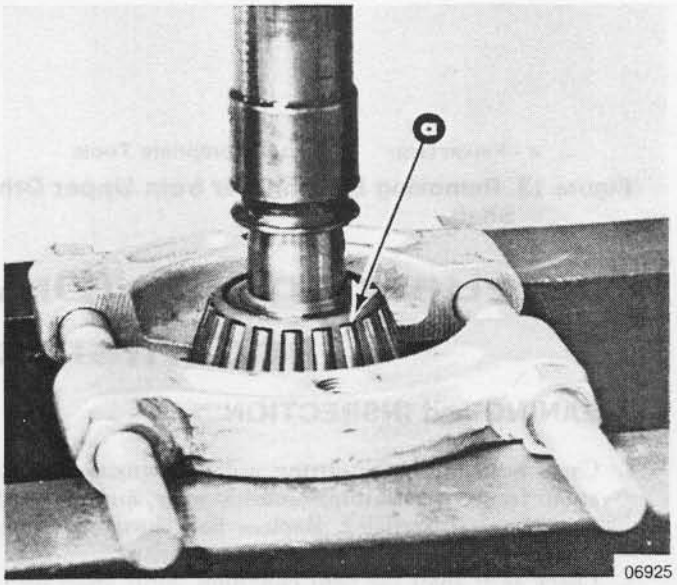
CLEANING and INSPECTION

1. Inspect driven gear for pitting, chipped or broken teeth and excessive or uneven wear. Replace gear if any of these exist.
2. Replace tapered roller bearings and bearing cups, if cups are pitted, grooved, scored, worn uneven, discolored from overheating or have foreign metal particles embedded in the cup.
3. Inspect surface of driven gear shaft where oil seal lip contacts the shaft. Any groove in shaft in this area requires gear replacement.

DISASSEMBLY

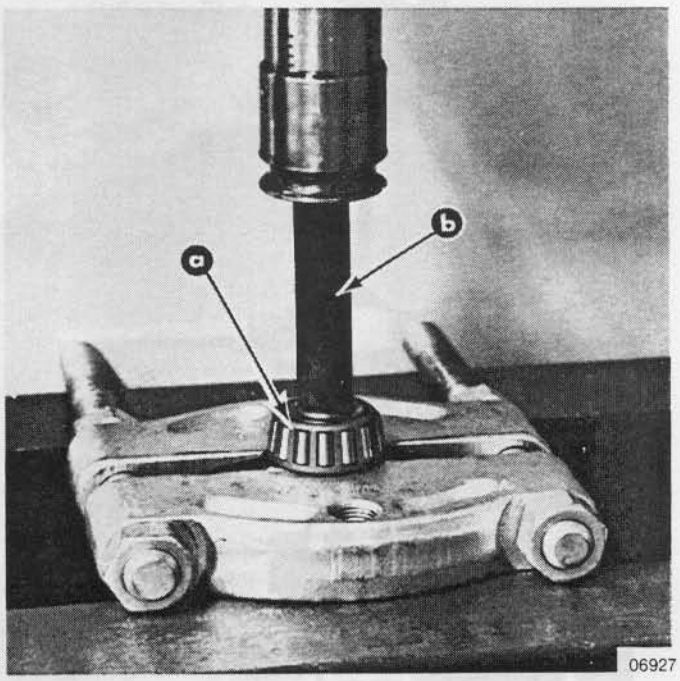
CAUTION: DO NOT remove bearings unless replacement is necessary.

1. Use Universal Puller Plate (C-91-37241) and arbor press to remove tapered roller bearing from driven gear. Press on splined end of driven gear. (Figure 11)



a - Driven Gear Bearing Assembly

Figure 11. Removing Driven Gear Bearing

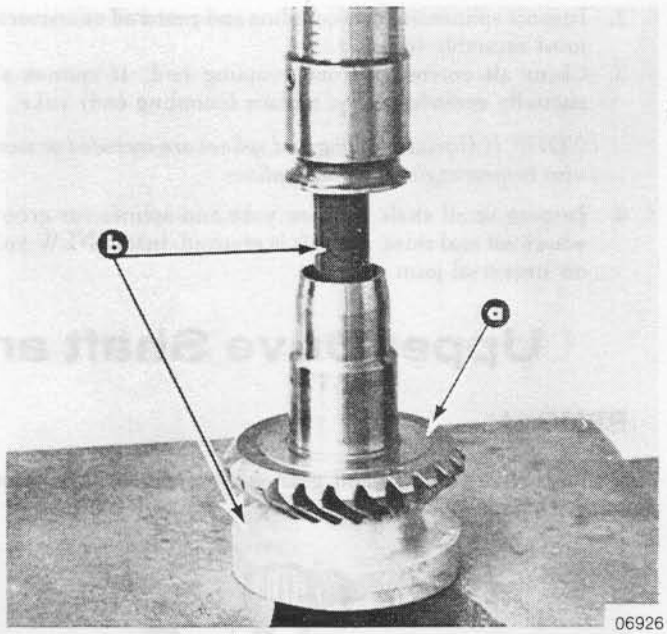


a - Upper Drive Shaft Bearing Assembly b - Appropriate Tool

Figure 12. Removing Upper Drive Shaft Bearing Assembly

NOTE: To achieve proper support from universal puller plate, it may be necessary to press on the side of the puller plate to separate bearing from shoulder, then finish press as shown.

2. With Universal Puller Plate (C-91-37241) placed under upper drive shaft bearing and, using appropriate tool, press bearing from drive shaft on an arbor press. (Figure 12)
3. Support driven gear with puller plate or proper means of support and press upper drive shaft from driven gear with appropriate tool. (Figure 13)
4. Remove "O" ring from lower end of drive shaft.



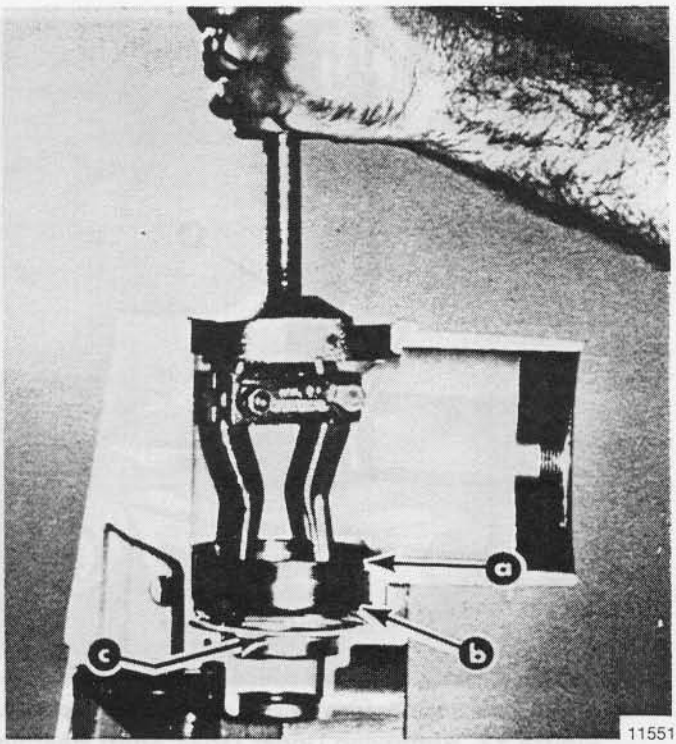
a - Pinion Gear b - Appropriate Tools

Figure 13. Removing Driven Gear from Upper Drive Shaft

Bearing Cup (Driven Gear) and Oil Seals and Intermediate Shift Shaft

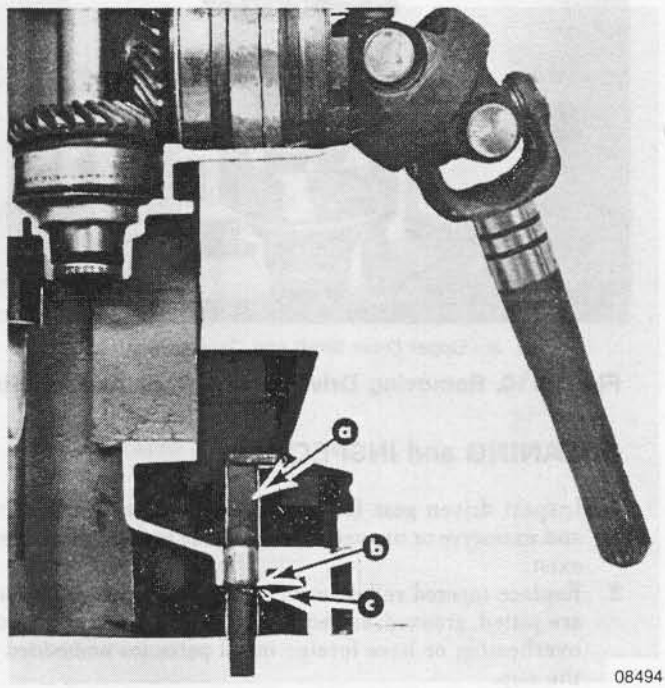
CLEANING and INSPECTION

1. Check bearing cup for pitting, grooves, scoring, discoloration from overheating, uneven wear and embedded foreign metal particles. Replace both bearing cup and bearing, if any of these conditions exist.
2. Check shift shaft for bent condition. Shift shaft may be bent if installation of drive unit is attempted without drive unit shifted into forward gear position.



a - Bearing Cup b - Shims c - Upper Oil Seal

Figure 14. Removing Shims

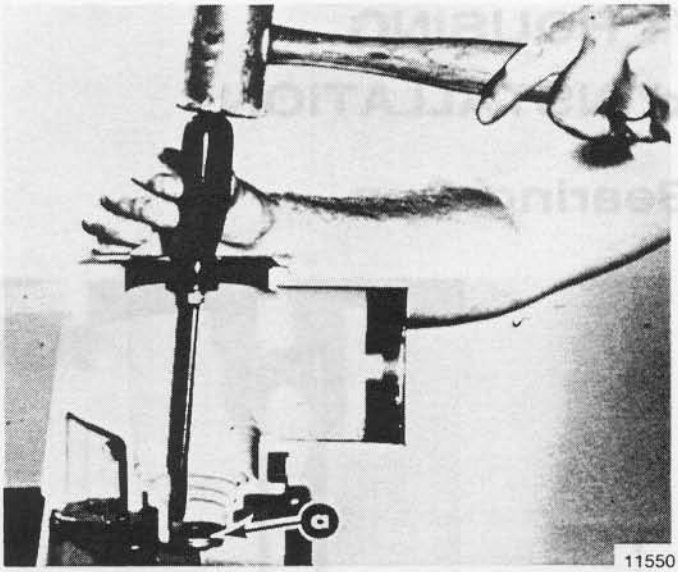


a - Shift Shaft b - Washer c - Cotter Pin

Figure 15. Removing Intermediate Shift Shaft

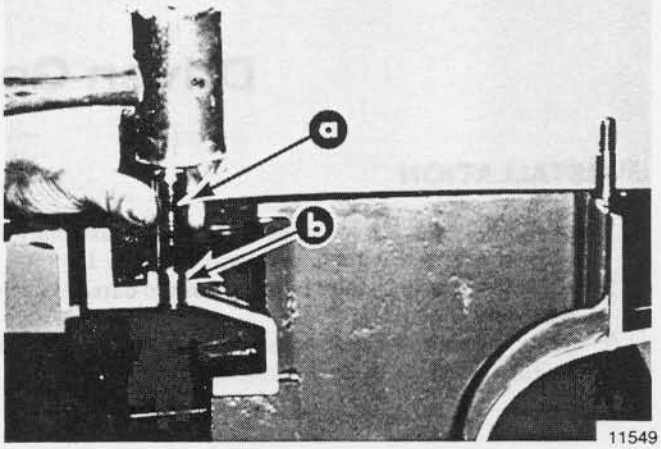
REMOVAL

1. Use Slide Hammer (C-91-34569A1, with 2-jaw head) to remove driven gear bearing cup and upper seal from drive shaft housing. Remove driven gear bearing cup shim(s) and retain them for reassembly. (Figure 14)
2. Remove intermediate shift shaft retaining cotter pin, washer and shift shaft. (Figure 15)
3. Remove drive shaft lower seal with screwdriver. (Figure 16)
4. Remove shift shaft bushing as shown in Figure 17.



a - Lower Seal

Figure 16. Removing Drive Shaft Lower Seal



a - Appropriate Tool b - Shift Shaft Bushing

Figure 17. Removing Shift Shaft Bushing

Drive Shaft Housing Body

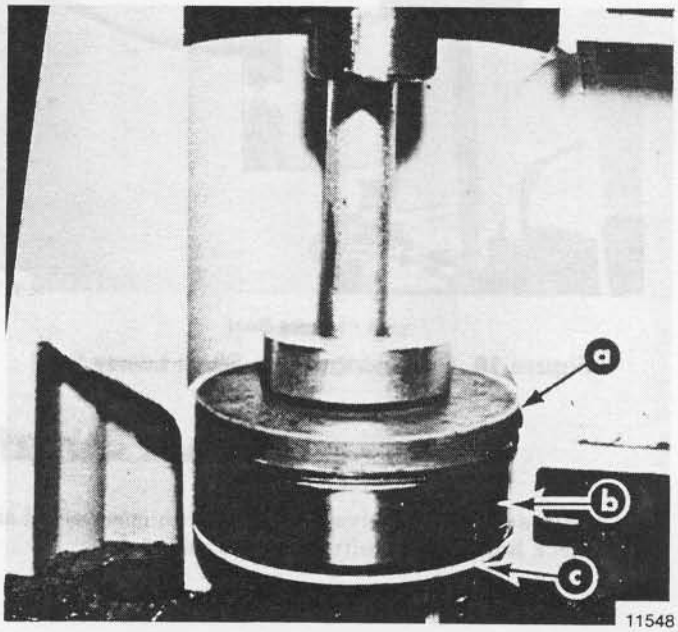
1. Clean assembly in solvent and dry with compressed air.
2. Check housing carefully for impact damage.
3. Check for loose fitting bearing cups.
4. Inspect condition of housing painted surface.

DRIVE SHAFT HOUSING REASSEMBLY and INSTALLATION

Driven Gear Bearing Cup

INSTALLATION

1. Place shim(s), which were retained from disassembly, into the driven gear bearing cup cavity. (Figure 1)
2. Apply a thin coat of U-Joint Lubricant to outside of driven gear bearing cup.
3. Drive or press driven gear bearing cup into housing with Bearing Cup Driver (C-91-33493). (Figure 1)



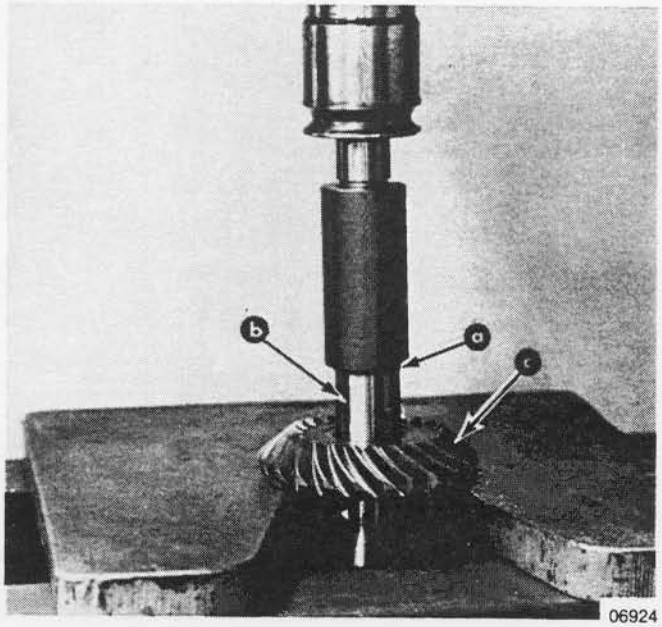
a - Bearing Cup Driver (C-91-33493)
b - Bearing Cup
c - Shims

Figure 1. Replacing Shims

Upper Drive Shaft and Driven Gear Assembly

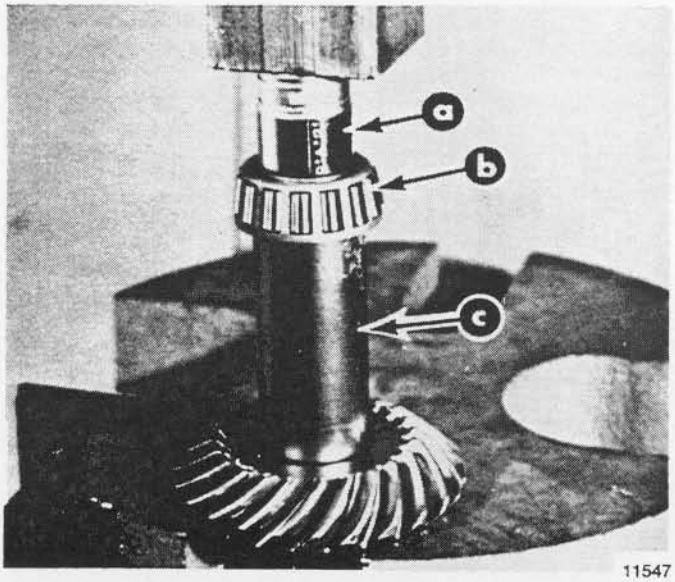
REASSEMBLY

1. Place "O" ring on driven gear end of upper drive shaft. (Figure 2)



a - "O" Ring b - Upper Drive Shaft c - Driven Gear

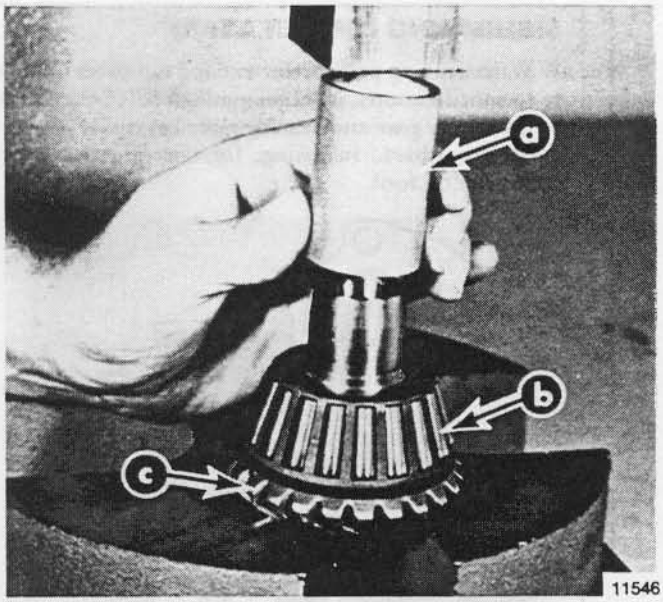
Figure 2. Pressing Upper Drive Shaft into Driven Gear



a - Appropriate Tool b - Tapered Bearing c - Drive Shaft

Figure 3. Pressing Tapered Bearing onto Drive Shaft

2. Apply a thin coat of U-Joint Lubricant to inner diameter of driven gear.
3. Press upper drive shaft into driven gear. (Figure 2)
4. Apply a thin coat of U-Joint Lubricant to inner diameter of drive shaft upper roller bearing.



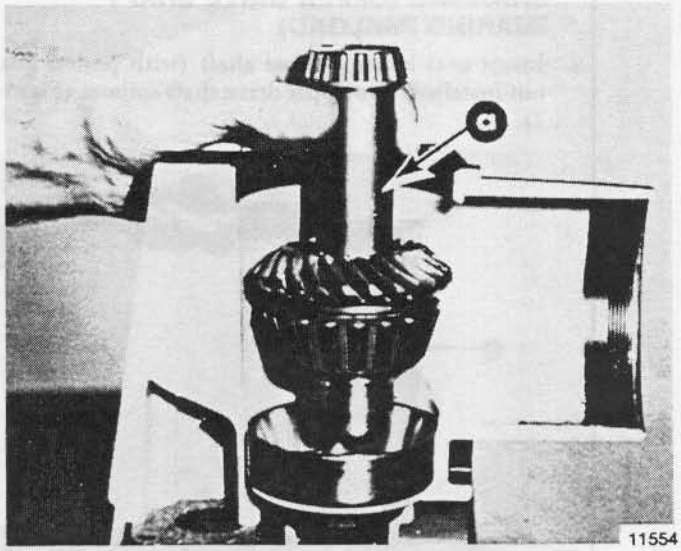
a - Appropriate Tool b - Bearing c - Driven Gear

Figure 4. Pressing Bearing onto Driven Gear

5. Use appropriate adaptor, so that pressing force will be applied to inner bearing race (old bearing race if available), and press upper drive shaft roller bearing into place until it seats on the shoulder of drive shaft. (Figure 3)
6. Apply a thin coat of U-Joint Lubricant to the inner diameter of driven gear tapered roller bearing.
7. Use appropriate adaptor, so that pressing force will be applied to inner bearing race (old bearing race if available), and press driven gear tapered roller bearing into place until it seats on the shoulder of driven gear. (Figure 4)

INSTALLATION

Set upper drive shaft and gear assembly into drive shaft housing. (Figure 5)



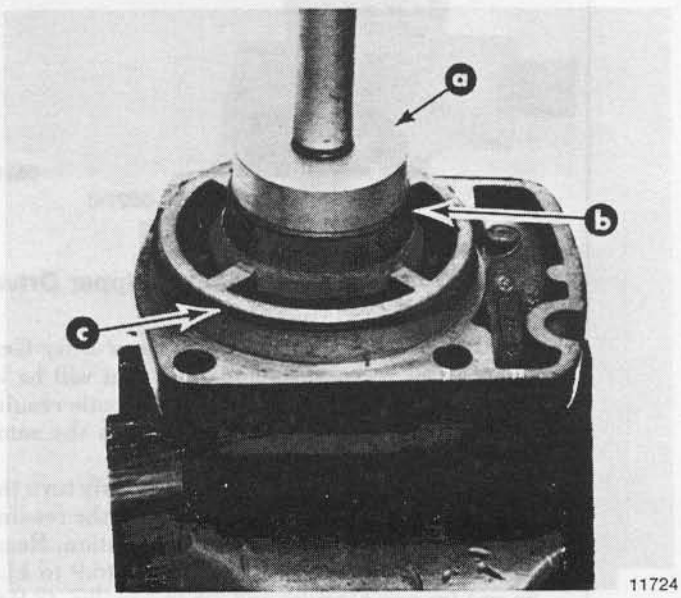
a - Upper Drive Shaft and Gear Assembly

Figure 5. Installing Upper Drive Shaft and Gear Assembly

Top Cover and Upper Drive Shaft Oil Seals

REASSEMBLY

1. Place shim(s), which were retained from disassembly, into top cover bearing cup cavity.
2. Install upper drive shaft tapered roller bearing cup with Bearing Cup Driver (C-91-38918). (Figure 6)
3. Place "O" ring on cover. (Figure 6)



a - Bearing Cup Driver (C-91-38918) b - Bearing Cup c - "O" Ring

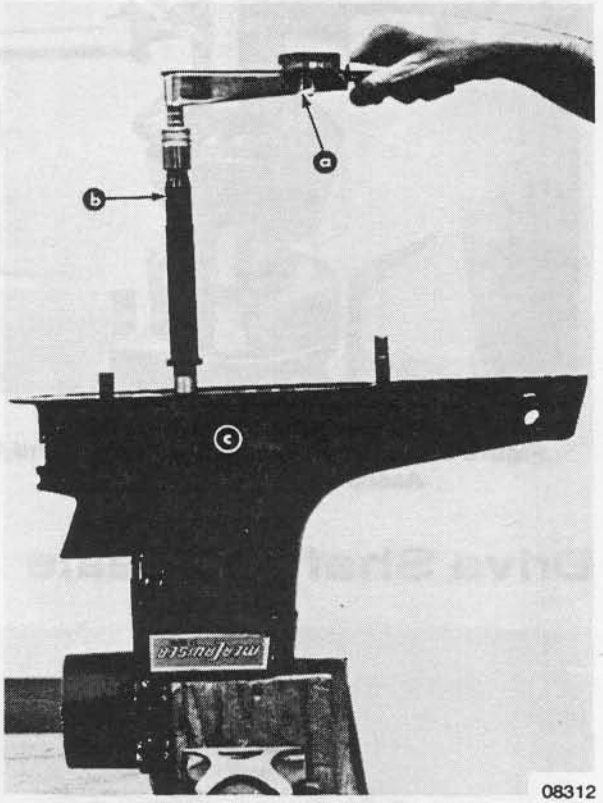
Figure 6. Installing Bearing Cup In Driver

INSTALLATION

1. Install cover assembly on drive shaft housing and torque the 4 securing screws to specifications. (Correct top cover torque is important to ensure proper bearing preload.) Check and correct (if necessary) upper drive shaft preload and driven gear height, as follows:

SHIMMING (UPPER DRIVE SHAFT BEARING PRELOAD)

a. Insert gear housing drive shaft (with pinion gear nut installed) into upper drive shaft splines. (Figure 7)



a - In. Lb. Torque Wrench (C-91-66274)
b - Drive Shaft from Gear Housing
c - Drive Shaft Housing

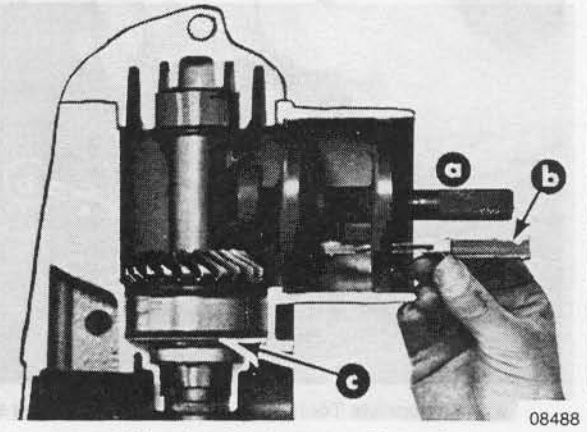
Figure 7. Determining Preload on Upper Drive Shaft

b. Apply a few drops of Quicksilver Super-Duty Gear Lubricant to all bearings and gears that will be involved. A dry bearing will give very erratic results.
c. Turn drive shaft several revolutions in the same direction to allow bearings to seat.
d. With an inch-pound torque wrench, slowly turn the shaft in the same direction and observe the reading while maintaining a smooth turning motion. Reading should be between 6-to-10 in. lbs. (6.9 to 11.5 kg-cm) for new bearings and 2½ to 4 in. lbs. (2.9 to 4.6kg-cm) if using original bearings.
e. If reading is too high, shims must be removed from under bearing cup in top cover. If reading is less than specified, shims must be added under bearing cup to obtain proper preload.

NOTE: If shim thickness in top cover is changed, top cover again must be torqued before remeasuring drive shaft bearing preload.

SHIMMING (DRIVEN GEAR)

a. With bearing preload correct and top cover torqued to specifications, place Shimming Tool (C-91-60526) into drive gear and bearing assembly cavity. (Figure 8). See chart, following, for correct position of shimming tool.



a - Shimming Tool (C-91-60526)
b - Feeler Gauge
c - Shims

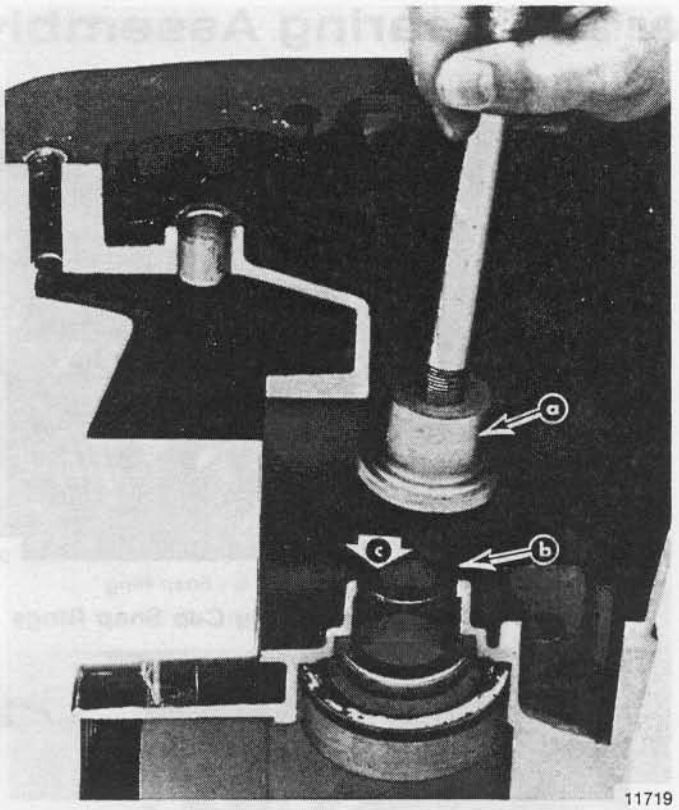
Figure 8. Measuring Driven Gear Clearance

Shimming Tool (C-91-60526)			
Tool Position Drive Model	X 165	Y 120-140 470	Z V-8's

b. Align proper shimming tool face (X-Y or Z) with 3 teeth of driven gear. Insert feeler gauge [.025" (0.64mm)] between one outside tooth of the 3 gear teeth which align with shimming tool face. Rotate shimming tool to obtain light drag on feeler gauge. Without moving shimming tool, insert feeler gauge between shimming tool and other outside tooth of aligned gear teeth.
c. If clearance is larger than feeler gauge being used, repeat preceding procedure (Step "b"), using thicker feeler gauge, until same clearance is obtained between each outside gear teeth and tool.
d. If clearance is smaller than feeler gauge being used, repeat preceding procedure (Step "b"), using thinner feeler gauge, until same clearance is obtained between both outside gear teeth and tool.

NOTE: The preceding procedure will position shimming tool face parallel with face of gear and obtain correct reading of clearance between gear and shimming tool.

e. Correct clearance is .025" (0.64mm). If clearance on gear being checked is less than .025", subtract clearance reading (obtained from .025") and remove shim(s) of that thickness from under driven gear tapered roller bearing cup. Also add shim(s) of same thickness under upper drive shaft bearing cup (in top cover) to maintain preload.
f. If clearance is more than .025", subtract .025" from clearance reading obtained and add shims of that thickness under driven gear bearing cup. Also remove shim(s) of same thickness under upper drive shaft tapered bearing cup to maintain bearing preload.

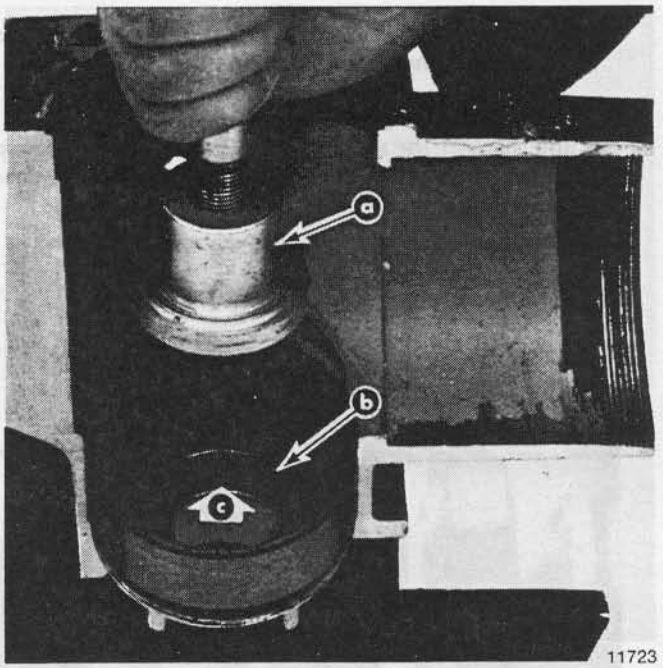


a - Oil Seal Driver (C-91-56032) b - Oil Seal c - Lip Facing Driven Gear

Figure 9. Installing Lower Drive Shaft Oil Seal

IMPORTANT: Recheck bearing preload according to previous instructions and rearrange shim(s) under bearing cup in top cover, if preload reading has changed. Recheck clearance.

2. After obtaining proper gear clearance and proper preload, remove top cover and driven gear assembly from housing.
3. Prior to installing lower drive shaft oil seal, apply a thin coat of Loctite Type "A" to outside diameter of seal.
4. Install lower drive shaft housing oil seal with lip facing driven gear. Use Oil Seal Driver (C-91-56032). (Figure 9)



a - Oil Seal Driver (C-91-56032) b - Oil Seal c - Lip Facing Driven Gear

Figure 10. Installing Upper Drive Shaft Oil Seal

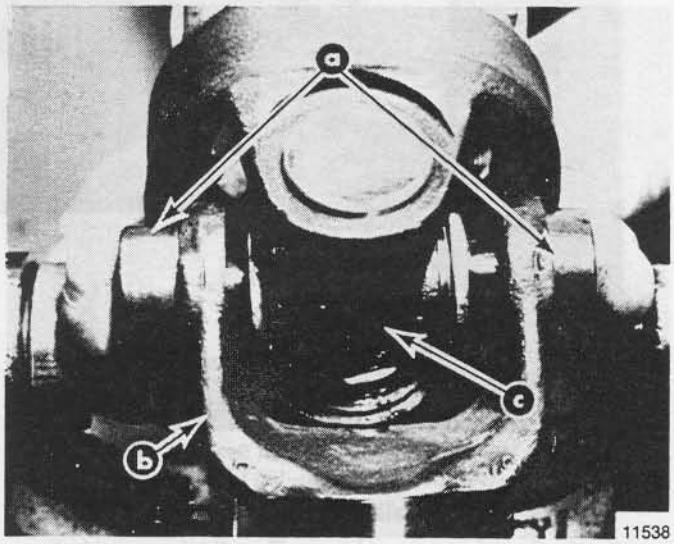
5. Apply a thin coat of Loctite Type "A" to outside diameter of top drive shaft oil seal and install seal.
6. Install top oil seal with lip facing toward driven gear. Use Oil Seal Driver (C-91-56032). (Figure 10)
7. Lubricate lip of seals with U-Joint Lubricant.
8. Place driven gear assembly into gear housing.
9. DO NOT install top cover until universal joint, drive gear and bearing assembly have been installed, and drive gear shimming is completed (instructions following).

Universal Joint, Drive Gear and Bearing Assembly

REASSEMBLY

IMPORTANT: Use only Universal Joint Lubricant for lubricating universal joint bearings.

1. Use a universal joint bearing remover and installer tool and support the tool in a vise. Place the bearing cups in yoke cavities and position bearing cross within yoke, as shown. (Figure 1)

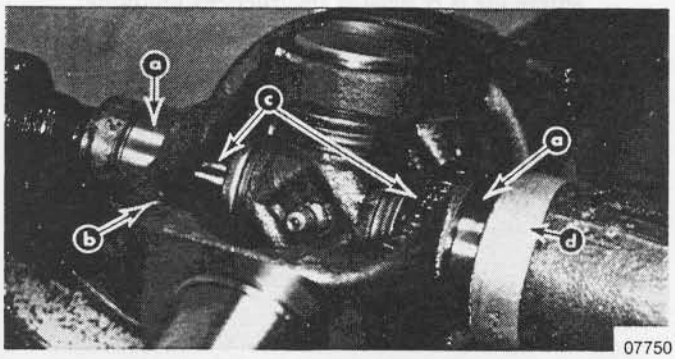


a - Bearing Cups b - Yoke c - Cross-Member

Figure 1. Installing Universal Joint Bearings

NOTE: When positioning cross in yoke, be sure that the grease fitting points toward longer shafted yoke (in both cases).

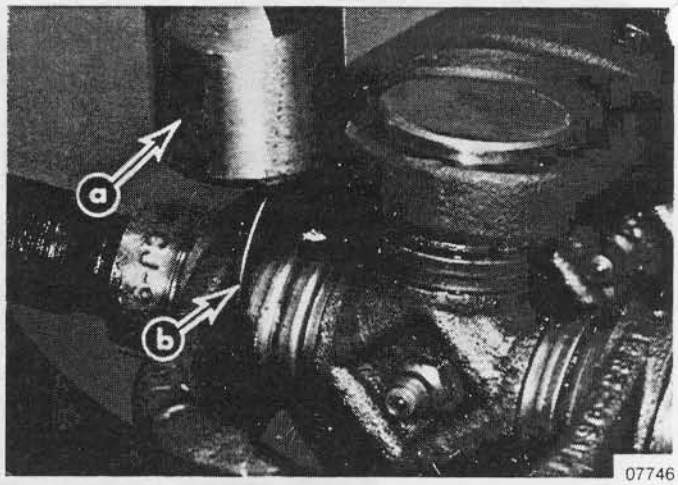
2. Press bearings through the yoke and onto cross. (Figure 2)



a - Bearing b - Yoke c - Cross-Member d - Adaptor

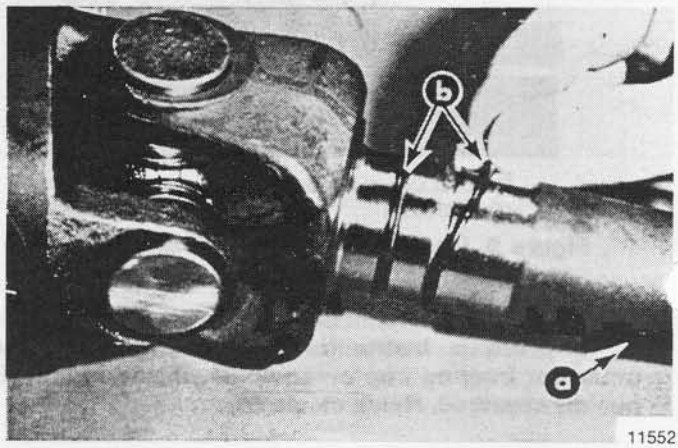
Figure 2. Installing Universal Joint Bearings

3. Install bearing cup retaining snap rings. (Figure 3)
4. Install each pair of bearings in this manner.
5. Install 2 rubber "O" rings on coupling end of universal joint yoke. (Figure 4)



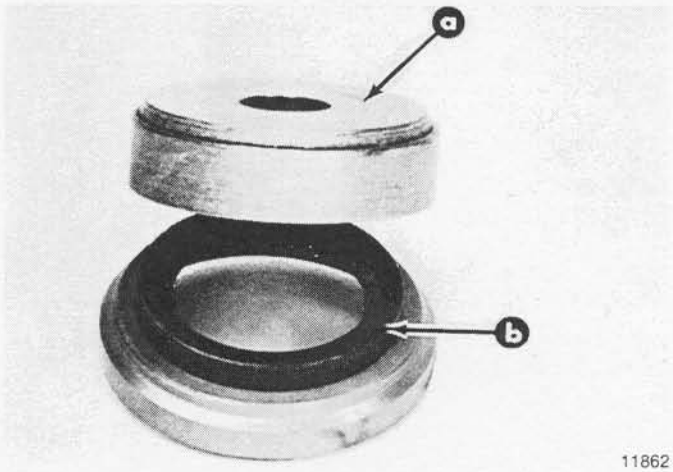
a - Hammer b - Snap Ring

Figure 3. Installing Bearing Cup Snap Rings



a - Coupling End b - "O" Ring

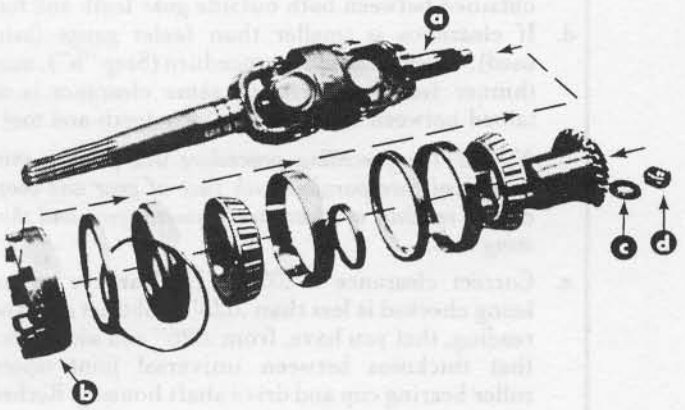
Figure 4. Installing "O" Rings on Universal Joint Yoke



a - Driver Cup (C-91-36577) b - Oil Seal

Figure 5. Pressing Oil Seal into Oil Seal Carrier

6. Press large oil seal into oil seal carrier (with lip of seal facing concave side of carrier) until seal is flush with carrier. Use Bearing Cup Driver (C-91-36577). Lubricate lip of seal with U-Joint Lubricant. (Figure 5)
7. Place one end of a suitable bar in a vise and other end through the universal joint yoke for holding purposes.
8. Place component parts of drive gear bearing assembly on drive gear shaft in the order shown in Figure 6. Start first with threaded retainer.

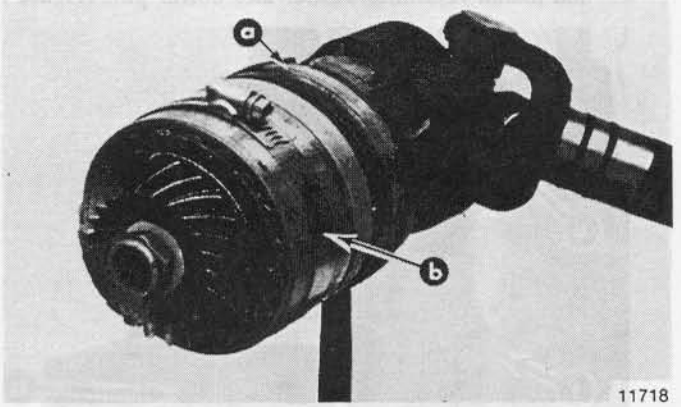


a - Drive Gear Shaft
b - Threaded Retainer
c - Washer
d - Nut

Figure 6. Reassembling Drive Gear Bearing Assembly

NOTE: If using original bearings, be sure to install in same position from which they were removed.

9. Place drive gear, washer (concave side facing gear) and nut on drive gear shaft. (Figure 6)
10. Before torquing nut to specifications, place a large hose clamp around the preload spacer (located between the bearing cups). (Figure 7) This is to assist in holding preload spacer in position while torquing nut.



a - Bearing Assembly
b - Hose Clamp Positioned over Preload Spacer

Figure 7. Positioning Preload Spacer

11. Torque nut to specifications and remove hose clamp.

NOTE: Torque on the universal joint shaft nut applies correct preload on drive gear assembly and torque must be correct.

INSTALLATION

1. Remove top cover assembly (if not already removed).
2. Install shims and spacer that were removed (and retained) from between the universal joint roller bearing cup and drive shaft housing. (Figure 10)

CAUTION: MerCruiser drive units with same number of teeth on both gears [in drive shaft housing (24 to 24)] have identification marks on drive and driven gears. These marks must be matched, as shown in Figure 8, whenever gears are installed into drive shaft housing. This condition occurs in 1.65 to 1 ratio stern drive units.

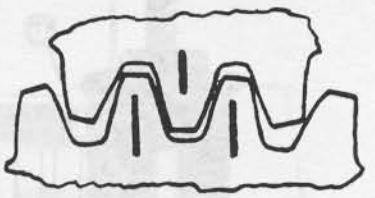
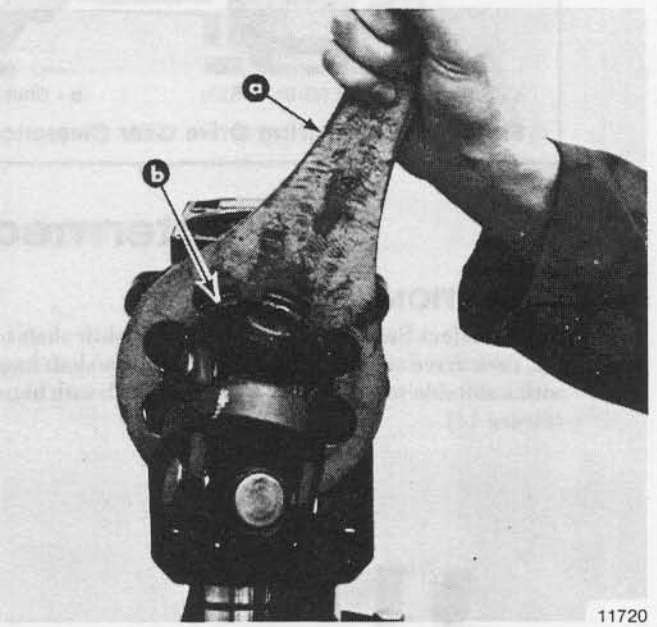


Figure 8. Matching Gear Identification Marks



a - Retainer Wrench (C-91-36235)
b - Retainer

Figure 9. Installing Bearing Retainer

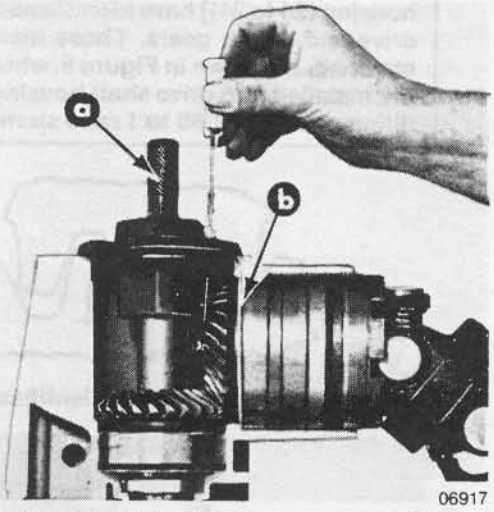
3. Install universal joint and drive gear assembly into drive shaft housing. Torque bearing retainer nut to specifications. (Figure 9) Check and correct (if necessary) drive gear to driven gear clearance, as follows:

SHIMMING (DRIVE GEAR)

a. Place Shimming Tool (C-91-60523) into drive shaft housing top cover cavity. (Figure 8) See chart (following) for correct position of shimming tool to be used.

SHIMMING TOOL (C-91-60523)

Tool Position	X	Y	Z
Drive Unit Model	120-140 (Serial No. 2791956 and Below)	120-140 (Serial No. 2791957 and Above) 165 and 470	V-8's



a - Shimming Tool (C-91-60523) b - Shims

Figure 10. Measuring Drive Gear Clearance

b. Align proper shimming tool face (X-Y or Z) with 2 or 3 teeth (depending upon gear ratio) of driven gear. Insert feeler gauge [.025" (0.64mm)] between one outside tooth of aligned gear teeth and shimming tool. Rotate shimming tool to obtain light drag on feeler gauge, then (without moving shimming tool) insert feeler gauge between shimming tool and other outside tooth of aligned gear teeth.

c. If clearance is larger than feeler gauge, which is being used, repeat preceding procedure (Step "b"), using thicker feeler gauge until same clearance is obtained between both outside gear teeth and tool.

d. If clearance is smaller than feeler gauge (being used), repeat preceding procedure (Step "b"), using thinner feeler gauge until same clearance is obtained between both outside gear teeth and tool.

NOTE: The preceding procedure will position shimming tool face parallel with face of gear and obtain correct reading of clearance between gear and shimming tool.

e. Correct clearance is .025". If clearance on gear being checked is less than .025", subtract clearance reading, that you have, from .025" and add shims of that thickness between universal joint tapered roller bearing cup and drive shaft housing. Recheck clearance.

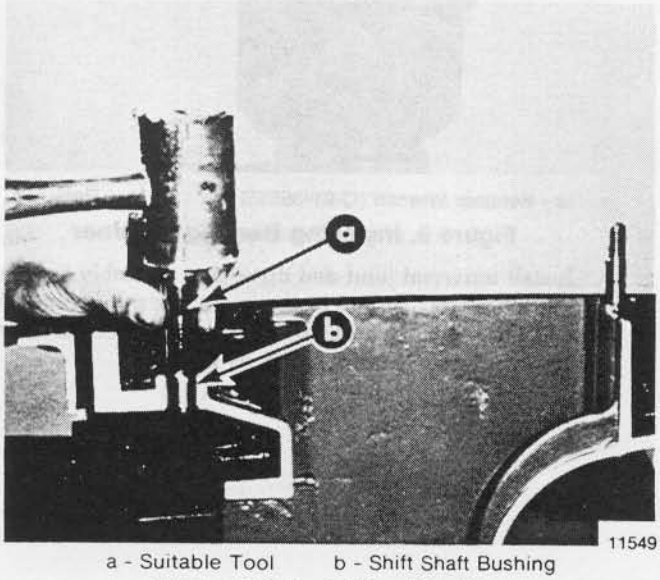
f. If clearance is more than .025", subtract .025" from clearance reading, that you have, and remove shims of that thickness from between universal joint tapered roller bearing cup and drive shaft housing. Recheck clearance.

4. Install top cover (with "O" ring), torquing 4 securing screws to specifications.

Intermediate Shift Shaft

INSTALLATION

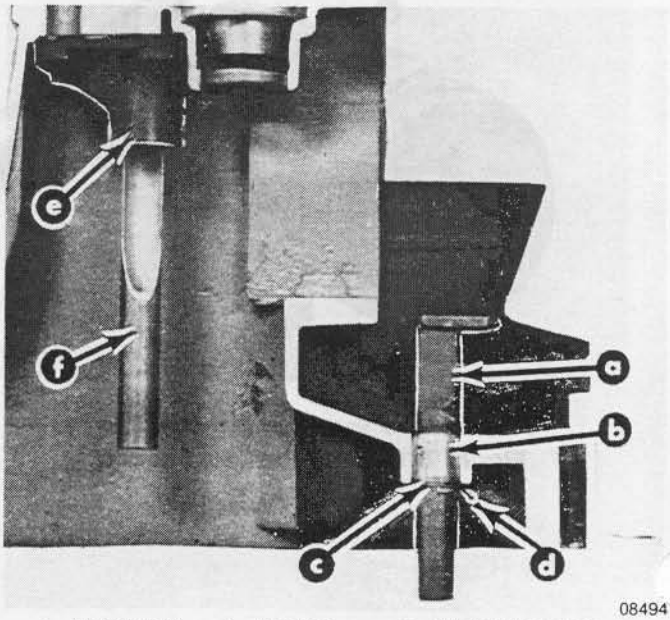
1. Apply Perfect Seal to outside diameter of shift shaft bushing, then drive shift shaft bushing into drive shaft housing with a suitable tool until the bushing is flush with housing. (Figure 11)



a - Suitable Tool b - Shift Shaft Bushing

Figure 11. Installing Bushing

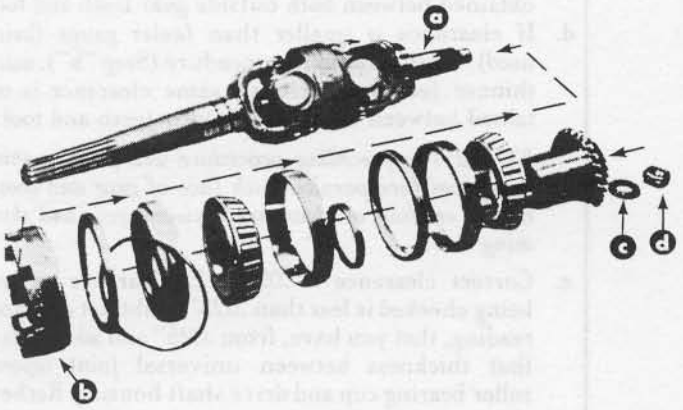
2. Place intermediate shift shaft through shift shaft bushing and install retaining washer and cotter pin. (Figure 12)



a - Shift Shaft c - Washer e - Water Pocket Cover
b - Bushing d - Cotter Pin f - Water Tube

Figure 12. Installing Shift Shaft

6. Press large oil seal into oil seal carrier (with lip of seal facing concave side of carrier) until seal is flush with carrier. Use Bearing Cup Driver (C-91-36577). Lubricate lip of seal with U-Joint Lubricant. (Figure 5)
7. Place one end of a suitable bar in a vise and other end through the universal joint yoke for holding purposes.
8. Place component parts of drive gear bearing assembly on drive gear shaft in the order shown in Figure 6. Start first with threaded retainer.



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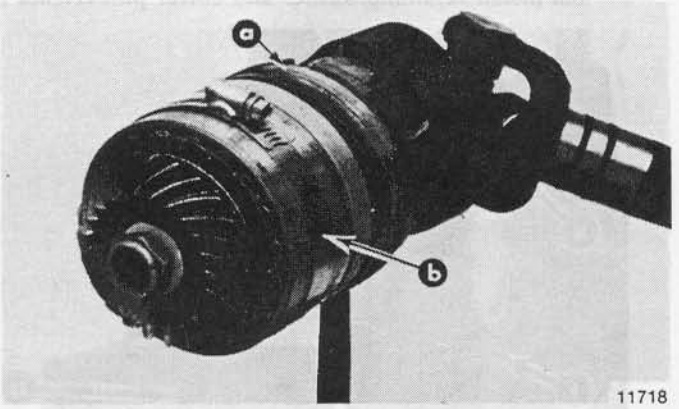
a - Drive Gear Shaft
b - Threaded Retainer
c - Washer
d - Nut

Figure 6. Reassembling Drive Gear Bearing Assembly

NOTE: If using original bearings, be sure to install in same position from which they were removed.

9. Place drive gear, washer (concave side facing gear) and nut on drive gear shaft. (Figure 6)
10. Before torquing nut to specifications, place a large hose clamp around the preload spacer (located between the bearing cups). (Figure 7) This is to assist in holding preload spacer in position while torquing nut.



11718

a - Bearing Assembly
b - Hose Clamp Positioned over Preload Spacer

Figure 7. Positioning Preload Spacer

11. Torque nut to specifications and remove hose clamp.

NOTE: Torque on the universal joint shaft nut applies correct preload on drive gear assembly and torque must be correct.

INSTALLATION

1. Remove top cover assembly (if not already removed).
2. Install shims and spacer that were removed (and retained) from between the universal joint roller bearing cup and drive shaft housing. (Figure 10)

CAUTION: MerCruiser drive units with same number of teeth on both gears [in drive shaft housing (24 to 24)] have identification marks on drive and driven gears. These marks must be matched, as shown in Figure 8, whenever gears are installed into drive shaft housing. This condition occurs in 1.65 to 1 ratio stern drive units.

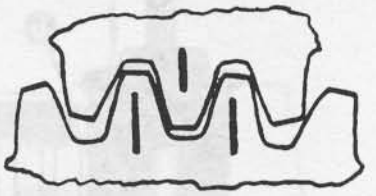
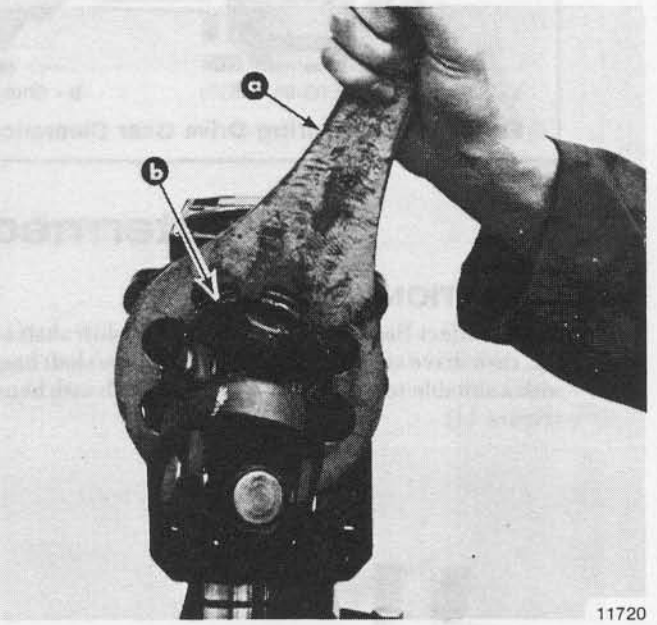


Figure 8. Matching Gear Identification Marks



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a - Retainer Wrench (C-91-36235)
b - Retainer

Figure 9. Installing Bearing Retainer

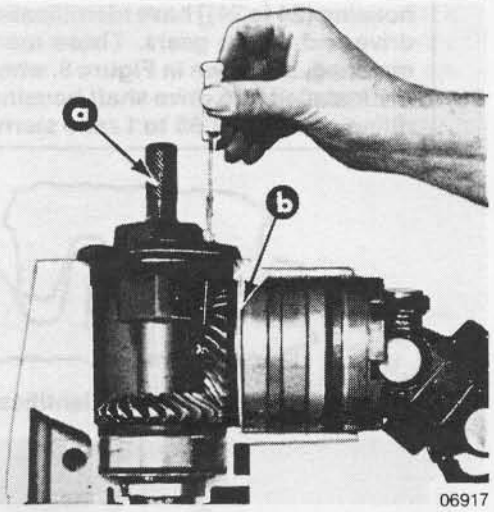
3. Install universal joint and drive gear assembly into drive shaft housing. Torque bearing retainer nut to specifications. (Figure 9) Check and correct (if necessary) drive gear to driven gear clearance, as follows:

SHIMMING (DRIVE GEAR)

a. Place Shimming Tool (C-91-60523) into drive shaft housing top cover cavity. (Figure 8) See chart (following) for correct position of shimming tool to be used.

SHIMMING TOOL (C-91-60523)

Tool Position	X	Y	Z
Drive Unit Model	120-140 (Serial No. 2791956 and Below)	120-140 (Serial No. 2791957 and Above) 165 and 470	V-8's



a - Shimming Tool (C-91-60523) b - Shims

Figure 10. Measuring Drive Gear Clearance

b. Align proper shimming tool face (X-Y or Z) with 2 or 3 teeth (depending upon gear ratio) of driven gear. Insert feeler gauge [.025" (0.64mm)] between one outside tooth of aligned gear teeth and shimming tool. Rotate shimming tool to obtain light drag on feeler gauge, then (without moving shimming tool) insert feeler gauge between shimming tool and other outside tooth of aligned gear teeth.

c. If clearance is larger than feeler gauge, which is being used, repeat preceding procedure (Step "b"), using thicker feeler gauge until same clearance is obtained between both outside gear teeth and tool.

d. If clearance is smaller than feeler gauge (being used), repeat preceding procedure (Step "b"), using thinner feeler gauge until same clearance is obtained between both outside gear teeth and tool.

NOTE: The preceding procedure will position shimming tool face parallel with face of gear and obtain correct reading of clearance between gear and shimming tool.

e. Correct clearance is .025". If clearance on gear being checked is less than .025", subtract clearance reading, that you have, from .025" and add shims of that thickness between universal joint tapered roller bearing cup and drive shaft housing. Recheck clearance.

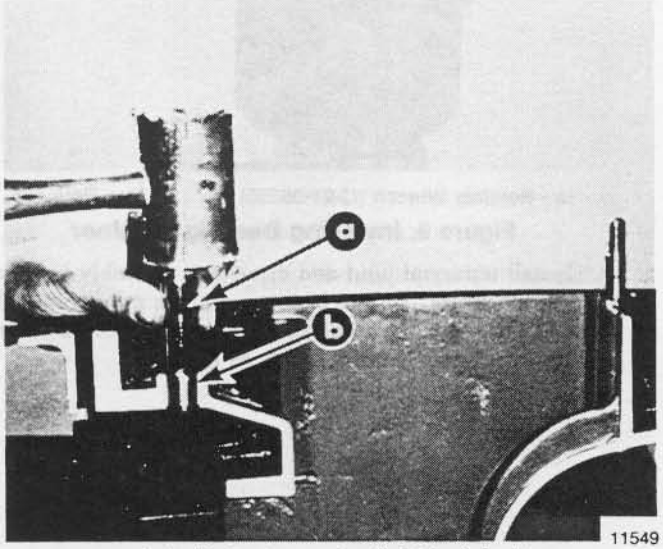
f. If clearance is more than .025", subtract .025" from clearance reading, that you have, and remove shims of that thickness from between universal joint tapered roller bearing cup and drive shaft housing. Recheck clearance.

4. Install top cover (with "O" ring), torquing 4 securing screws to specifications.

Intermediate Shift Shaft

INSTALLATION

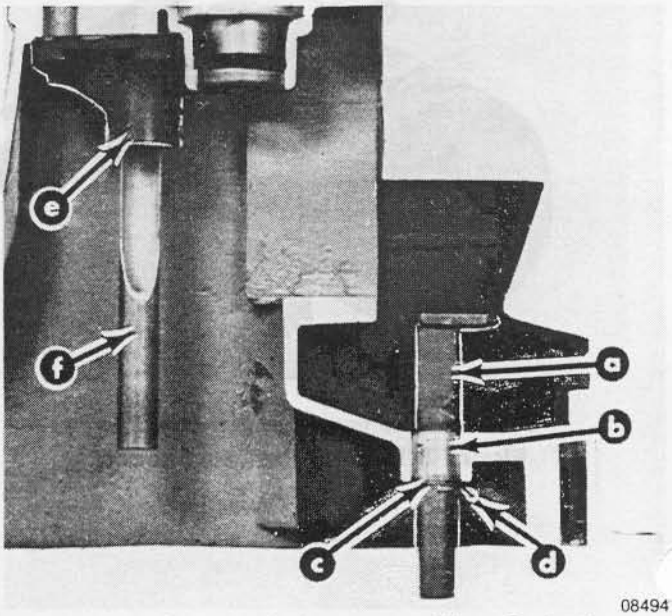
1. Apply Perfect Seal to outside diameter of shift shaft bushing, then drive shift shaft bushing into drive shaft housing with a suitable tool until the bushing is flush with housing. (Figure 11)



a - Suitable Tool b - Shift Shaft Bushing

Figure 11. Installing Bushing

2. Place intermediate shift shaft through shift shaft bushing and install retaining washer and cotter pin. (Figure 12)



a - Shift Shaft c - Washer e - Water Pocket Cover
b - Bushing d - Cotter Pin f - Water Tube

Figure 12. Installing Shift Shaft

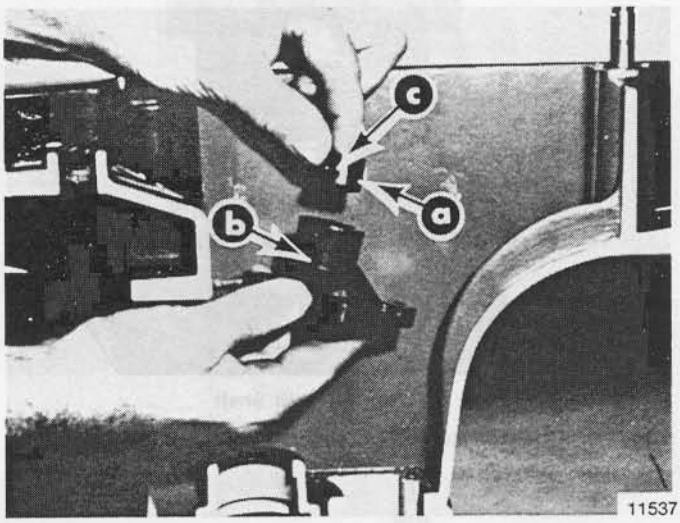
Water Pocket Cover

REASSEMBLY

Apply a light coat of U-Joint Lubricant to water pocket cover seal and install it into water pocket cover. Align retaining embossment of rubber seal with hole in pocket cover. (Figure 13)

INSTALLATION

1. Place NEW gasket and water pocket cover in position on drive shaft housing. (Figure 12)
2. Install screws and torque to specifications.
3. Install water tube into water pocket cover.

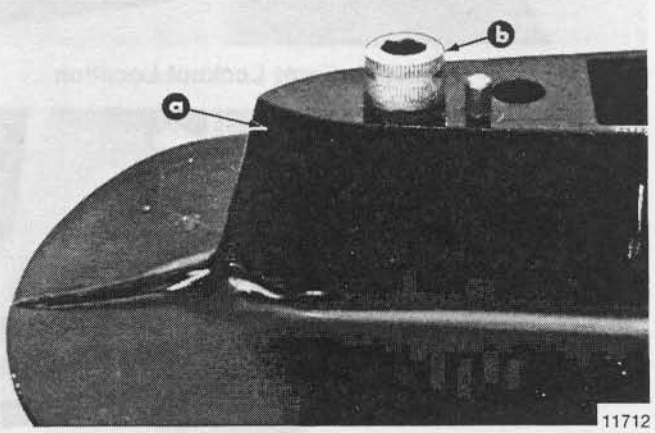


a - Seal b - Water Pocket Cover c - Embossment

Figure 13. Installing Seal in Water Pocket Cover

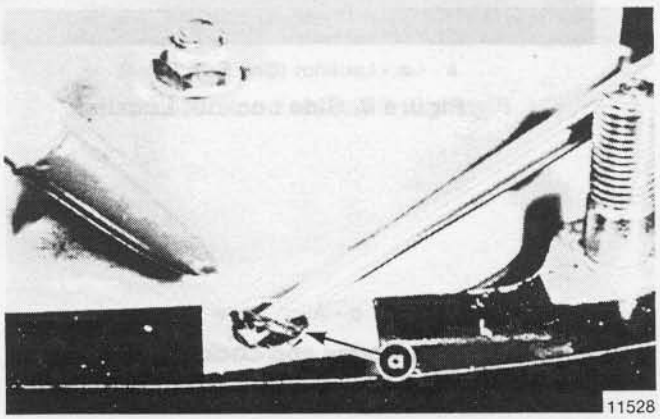
Installing Drive Shaft Housing to Gear Housing

1. Apply a light coat of U-Joint Lubricant on bottom end of water tube and a heavy coat of lubricant on the drive shaft splines.
2. Place trim tab allen screw in position. (Figure 1)



a - Gear Housing b - Trim Tab Allen Screw

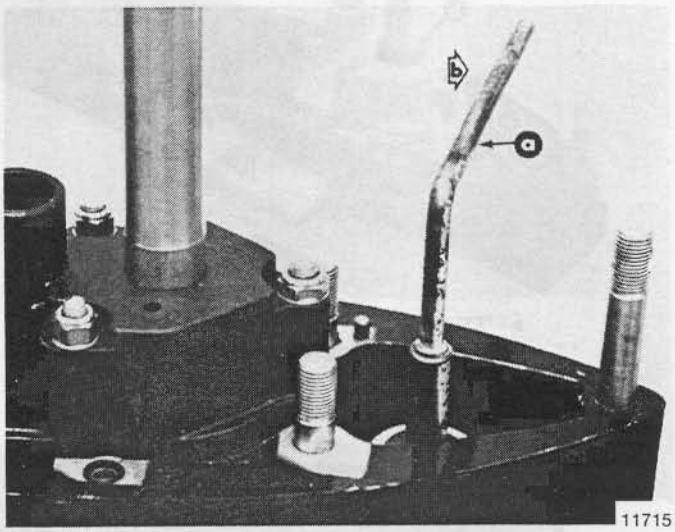
Figure 1. Placing Trim Tab Allen Screw in Position



a - Inter-Connecting Oil Seal

Figure 2. Inter-Connecting Oil Seal

3. Install seal in groove around gear housing to drive shaft housing inter-connecting oil passage and coat with Perfect Seal. (Figure 2)



a - Shift Shaft Wrench b - Farthest Position Forward

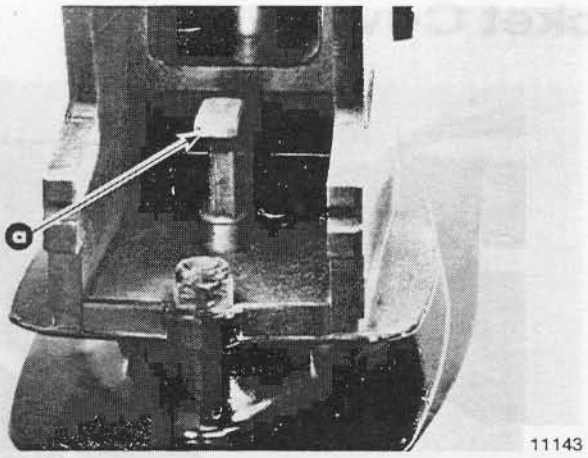
Figure 3. Full Forward Gear

4. Shift gear housing assembly into full forward gear. (Figure 3)

   NOTE: Gear housing assembly may be held in forward gear by applying slight pressure to propeller shaft in counter-clockwise direction.

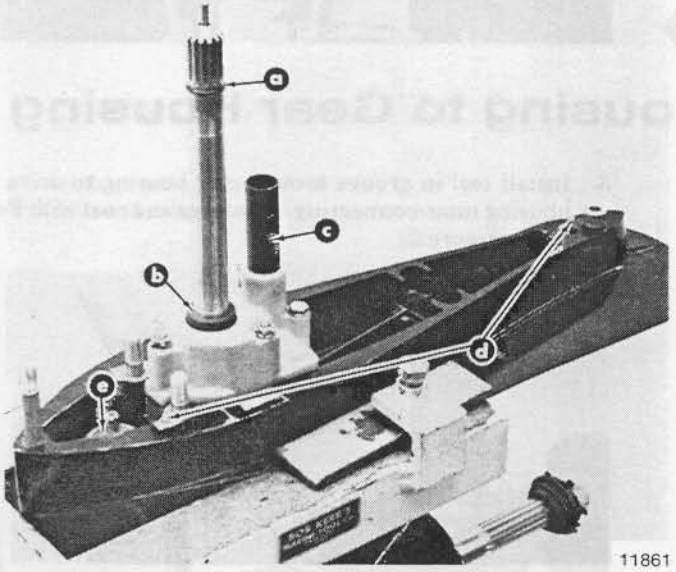
5. Position upper shift shaft (located in drive shaft housing) in full forward position. (Figure 4)

IMPORTANT: Before installing drive shaft housing to gear housing, be sure that alignment pins, centrifugal slinger and drive shaft "O" ring are in position. Also be sure that rubber and metal washers are in position on shift shaft and that plastic guide tube is installed into water pump cover. (Figure 5)



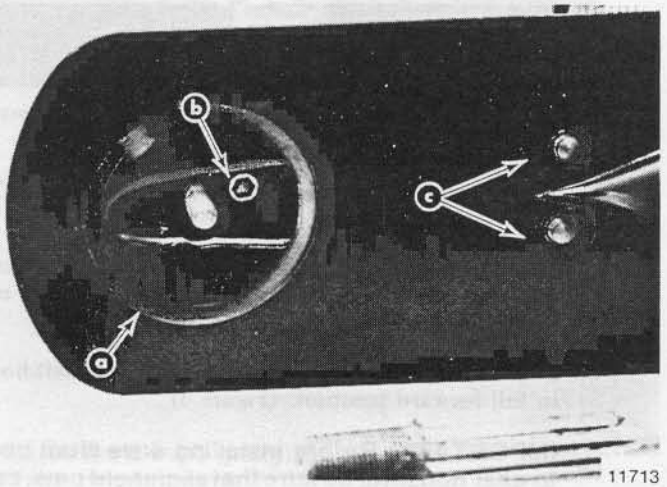
a - Shift Shaft

Figure 4. Shift Shaft Forward Position



a - "O" Ring
b - Centrifugal Slinger
c - Plastic Guide Tube
d - Alignment Pins
e - Metal Washer on Top of Rubber Washer

Figure 5. Gear Housing



a - Trim Tab Cavity
b - Allen Screw
c - Locknuts

Figure 6. Allen Screw and Locknut Location

6. Install drive shaft housing to gear housing. Align water tube with tube guide and drive shaft splines with upper drive shaft and shift shaft splines.

   NOTE: If propeller shaft is rotated in clockwise direction before shift shafts are coupled, gear housing must be shifted back into forward gear.

7. Rotate propeller shaft counterclockwise only after shift shaft splines have engaged. This is to help drive shaft splines enter upper drive shaft splines.
8. With 2 housings joined, install and tighten elastic stop nuts and allen screw. (Figures 6-7-8)

   NOTE: The side elastic stop nuts must be installed first.

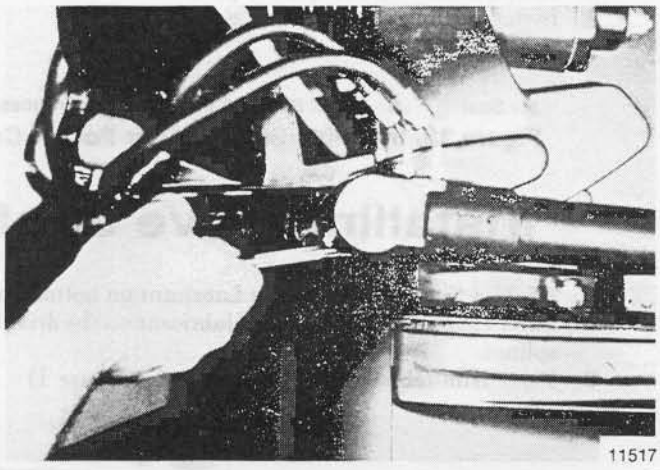
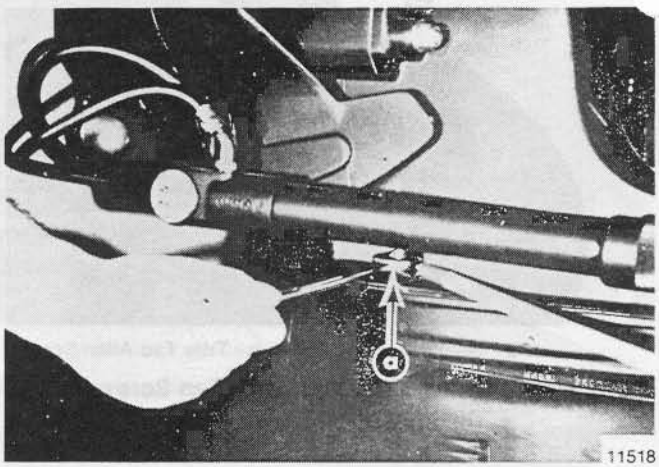


Figure 7. Front Locknut Location



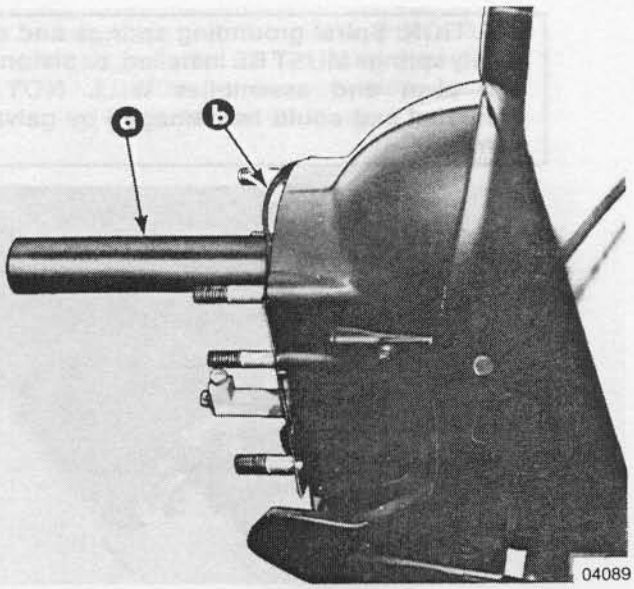
a - Locknut (One Both Sides)

Figure 8. Side Locknut Location

Installing Drive Shaft Housing to Gimbal Housing

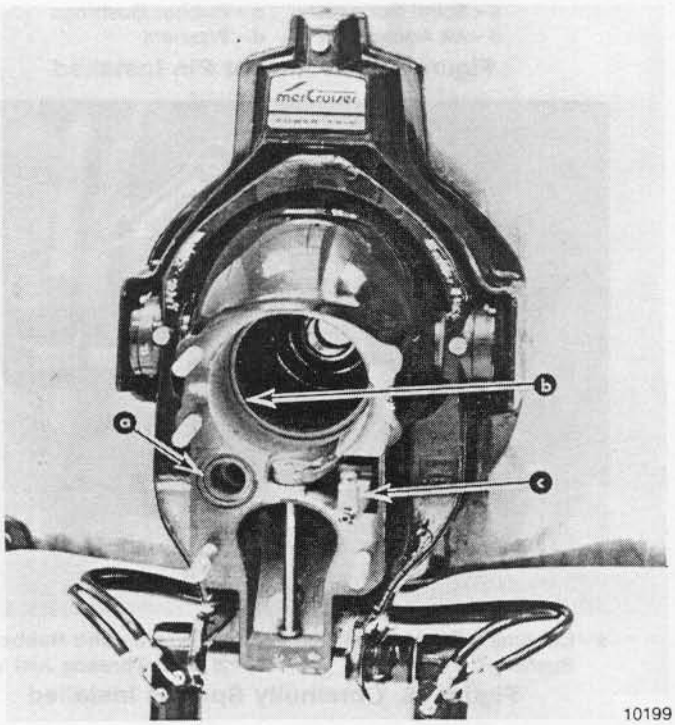
CAUTION: Check engine alignment with Engine Coupler Alignment Shaft (C-91-48247 or C-91-57797A3) before installing stern drive unit.

1. Engine alignment must be checked before the drive shaft housing is installed. Place alignment tool through the gimbal bearing and into engine. (Figure 9) If there is any resistance to the alignment tool when entering the engine, the engine must be aligned by raising or lowering front of engine. Front engine mount or mounts have accommodations for making adjustment.



a - Alignment Shaft b - Gasket

Figure 9. Aligning Engine



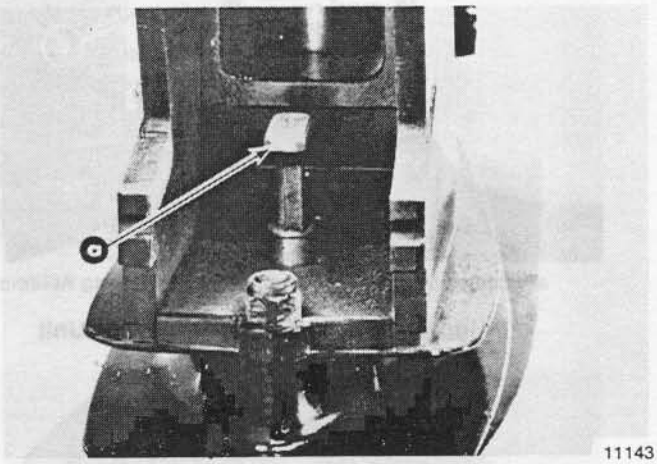
2. Place water passage "O" ring and rubber gasket in bell housing. Use general adhesive for holding seal and gasket in place. Now lubricate shift slide assembly with U-Joint Lubricant. (Figure 10)

   NOTE: Slide assembly is free to rotate on core wire, so be sure that slide is located in the upright position during installation, as shown in Figure 10.

3. Install drive shaft housing to bell housing gasket. (Figure 9)
4. Place drive unit in forward by positioning upper shift shaft as shown in Figure 11.

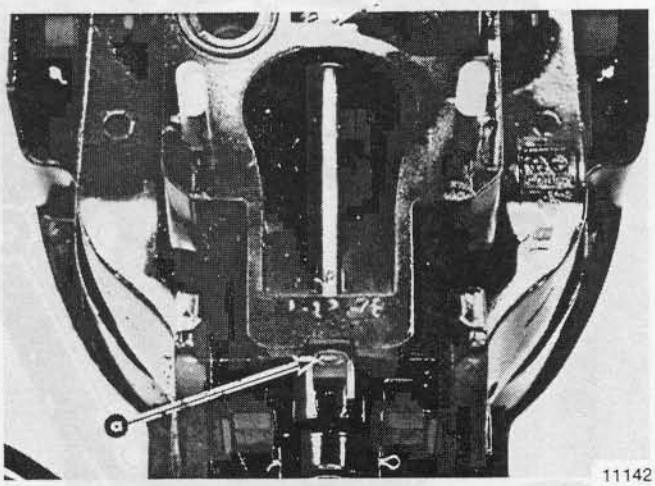
   NOTE: It may be necessary to rotate propeller shaft slightly to achieve full forward gear engagement.

5. Place shift mechanism in bell housing in forward gear position. (Figure 12)



a - Upper Shift Shaft

Figure 11. Positioning Drive Unit in Forward Gear



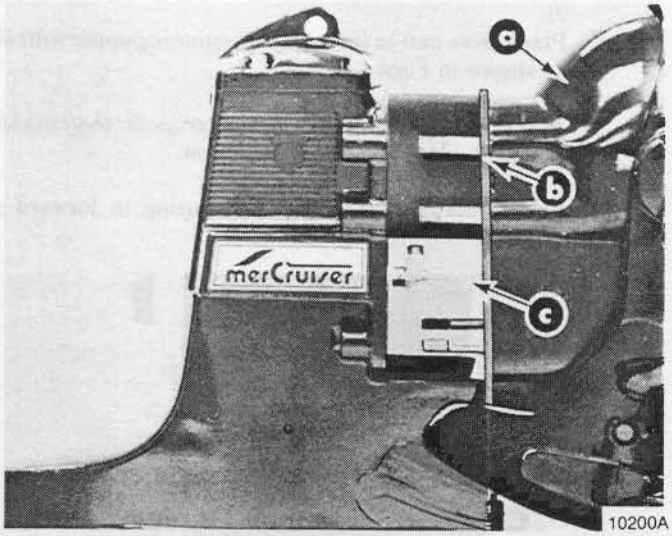
a - Shift Coupling Slot

Figure 12. Positioning Bell Housing Shift Mechanism in Forward Gear Position

a - "O" Ring b - Rubber Gasket c - Shift Slide Assembly

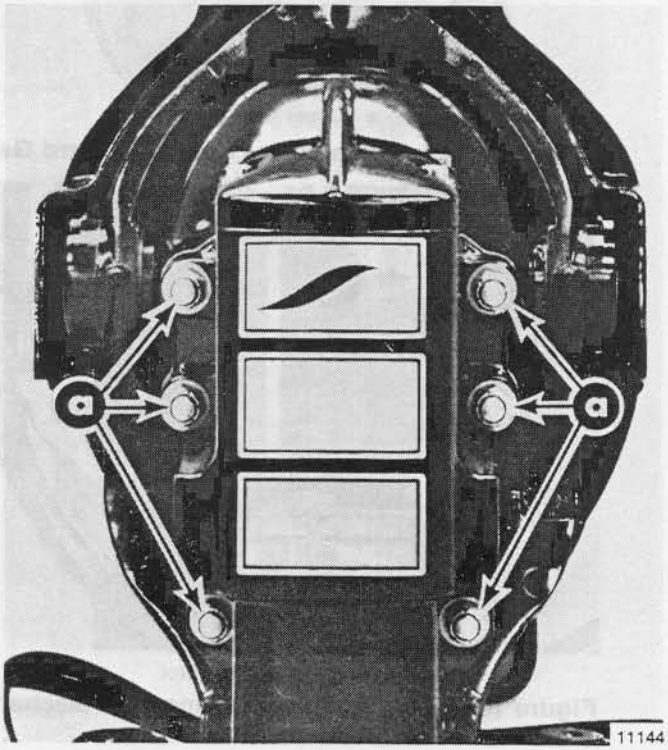
Figure 10. Positioning "O" Ring, Rubber Gasket and Shift Slide Assembly

6. Apply Universal Joint Lubricant from U-Joint Kit to universal joint splines and "O" rings and install drive shaft housing to gimbal housing, as follows: (Figure 13)
   a. Guide universal joint shaft thru bearing in gimbal housing into drive coupling on engine while guiding shift slide into opening in drive shaft housing.
   b. Be careful not to move shift slide assembly or coupler. The unit will not align if out of position.
   If drive shaft splines do not align with engine coupling splines, rotate propeller shaft counterclockwise until drive unit can be pushed into position. Propeller should be placed on shaft for easier rotation.



a - Bell Housing b - Gasket c - Shifting Assembly

Figure 13. Installing Stern Drive Unit



a - Fastening Nuts

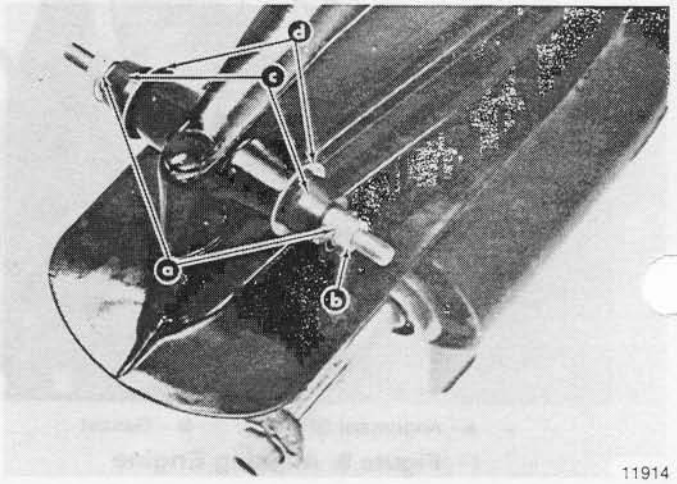
Figure 14. Fastening Drive Shaft Housing to Bell Housing

7. Lubricate threads on bell housing studs with Universal Joint Lubricant and fasten drive shaft housing to bell housing with 6 flat washers and elastic stop nuts. Torque evenly to specifications.

CAUTION: DO NOT apply oil or grease to rubber bushings, as this may cause bushings to creep out of position during operation.

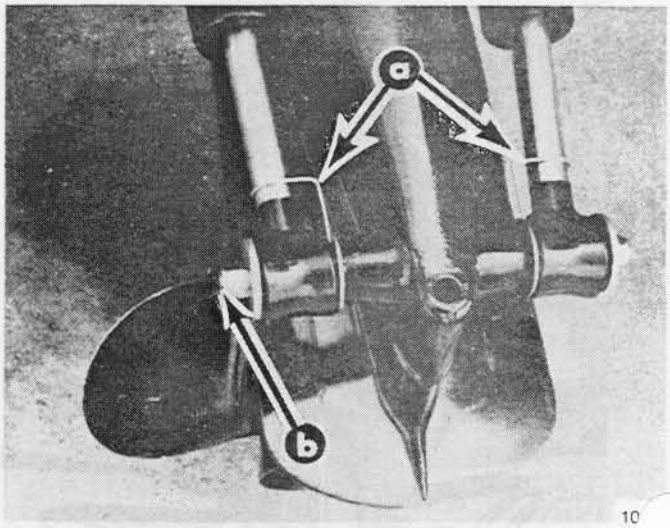
8. Insert aft anchor pin thru hole in drive shaft housing and place large ID flat washer, rubber bushing and spiral grounding spring on each end of pin, as shown in Figure 15. Be sure to install bushings with smaller diameter end outward.
9. Swing cylinders upward and position aft pivot ends on aft anchor pin.

CAUTION: Spiral grounding springs and continuity springs MUST BE installed, or piston rod and pivot end assemblies WILL NOT be grounded and could be damaged by galvanic corrosion.



a - Spiral Spring c - Rubber Bushings
b - Aft Anchor Pin d - Washers

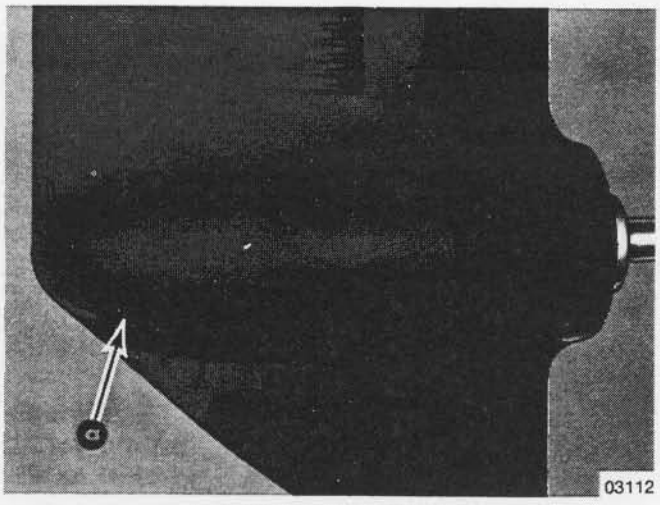
Figure 15. Aft Anchor Pin Installed



a - Continuity Springs Installed between Washer and Rubber Bushing b - Pin Threads Just Visible

Figure 16. Continuity Springs Installed

10. Place long end of continuity spring in-between the inner flat washer and rubber bushing, then slide spring forward until it clamps over aft anchor pin. Connect other end of continuity spring to hydraulic cylinder piston rod. (Figure 16)
11. Place rubber bushings (with small diameter end inward) and small ID flat washer into each end of aft anchor pin. Coat threads on anchor pin with Universal Joint Lubricant and thread on elastic stop nuts.
12. Tighten forward and aft anchor pin nuts until approximately 2 threads are exposed beyond each nut.
13. Fill drive unit with Quicksilver Super-Duty Gear Lubricant (C-92-65225) through fill hole in gear housing (Figure 17) until lubricant runs out of vent hole in drive shaft housing (approximately 32 fluid ounces). (Figure 18)



a - Filler and/or Drain Hole

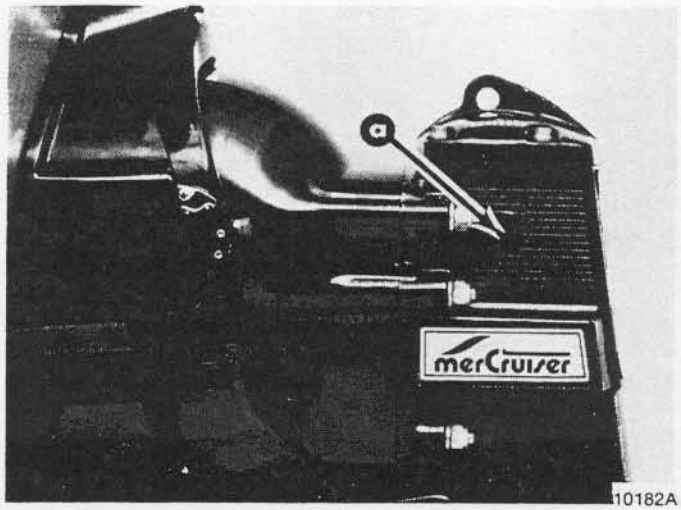
Figure 17. Fill Plug in Gear Housing

14. Install trim tab to original location (marked before removal), torque allen bolt to specifications and install plastic plug. (Figure 19)

    NOTE: If trim tab was not marked before removal, or a new trim tab is to be installed, refer to "Trim Tab Adjustment" in "General Information" Section 1.

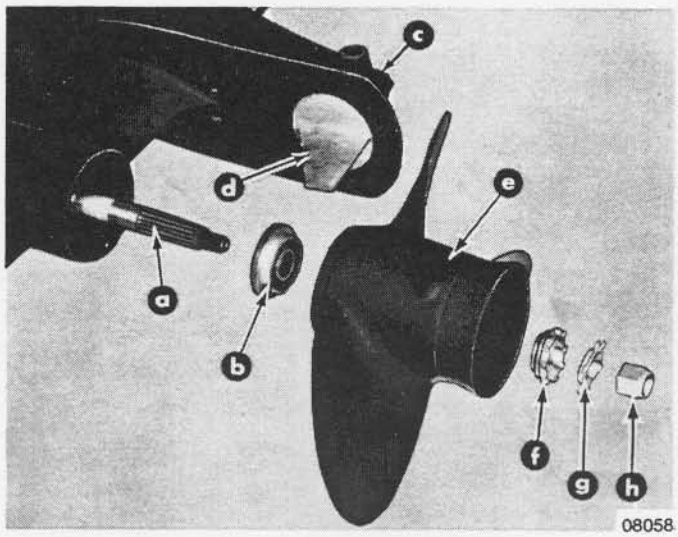
15. Install thrust hub, propeller, splined washer, tab washer and propeller nut. (Figure 19)

SAFETY WARNING: When installing (or removing) propeller retaining nut, place a block of wood between the anti-cavitation plate and propeller to protect the hands from propeller blades.



a - Oil Vent Plug

Figure 18. Vent Plug in Drive Shaft Housing



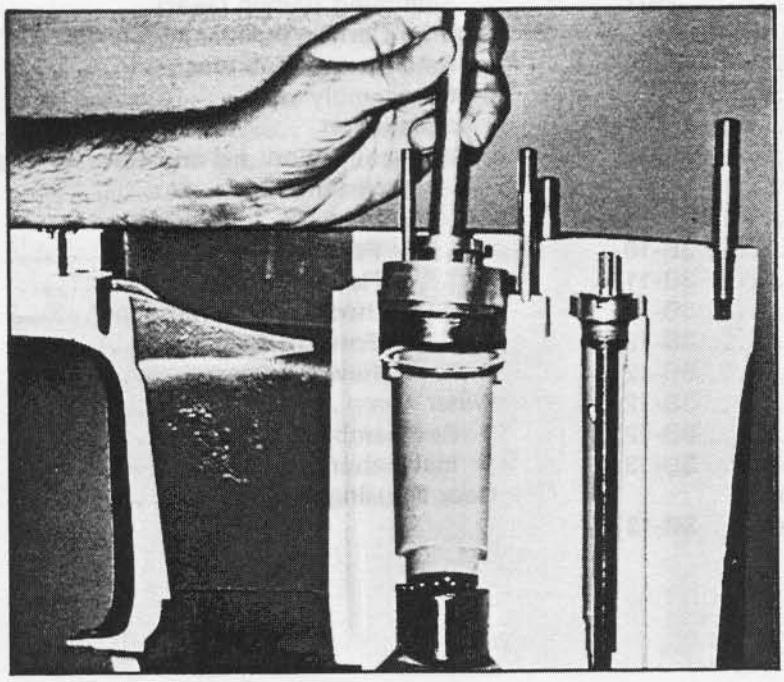
a - Propeller Shaft
b - Thrust Hub
c - Plastic Plug
d - Trim Tab
e - Propeller
f - Splined Washer
g - Tab Washer
h - Propeller Nut

Figure 19. Propeller and Trim Tab Installation

16. Place block of wood between propeller and anti-cavitation plate to prevent propeller from turning while torquing propeller nut to specifications. Bend tab washer tabs into slots (provided on splined washer) to lock propeller nut.

I-DRIVE

Drive Unit



SECTION 3

PART B

Gear Housing Assembly

INDEX

	Page
Tools and Torques	3B-1
Gear Housing Removal and Disassembly	3B-3
Separating Gear Housing from Drive Shaft Housing	3B-3
Water Pump	3B-4
Removal	3B-4
Cleaning and Inspection	3B-5
Disassembly	3B-5
Bearing Carrier, Reverse Gear, Carrier Retainer and Tab Washer	3B-6
Removal	3B-6
Cleaning and Inspection	3B-7
Disassembly	3B-7
Drive Shaft and Pinion Gear	3B-9
Removal	3B-9
Cleaning and Inspection	3B-9
Disassembly	3B-9
Propeller Shaft and Forward Gear Assembly	3B-10
Removal and Disassembly	3B-10
Cleaning and Inspection	3B-11
Shift Shaft	3B-12
Removal	3B-12
Cleaning and Inspection	3B-12
Disassembly	3B-12
Gear Housing	3B-12
Gear Housing Reassembly and Installation	3B-13
Roller Bearing (Drive Shaft) and Bearing Cups (Drive Shaft and Forward Gear)	3B-13
Installation	3B-13
Shift Shaft Assembly	3B-15
Reassembly	3B-15
Installation	3B-15
Propeller Shaft and Forward Gear Assembly	3B-16
Reassembly	3B-16
Installation	3B-17
Drive Shaft and Pinion Gear	3B-17
Reassembly	3B-17
Installation	3B-17
Shimming (Pinion Gear)	3B-18
Bearing Carrier, Reverse Gear, Carrier Retainer and Tab Washer	3B-18
Reassembly	3B-18
Installation	3B-19
Shimming (Forward and Reverse Gear Backlash)	3B-20
Method No. 1 - Shimming	3B-20
Forward Gear	3B-20
Reverse Gear	3B-20
Method No. 2 - Shimming	3B-20
Forward Gear	3B-20
Reverse Gear	3B-21
Water Pump	3B-22
Reassembly	3B-22
Installation	3B-23
Gear Housing Installation	3B-24

TOOLS and TORQUES

Special service tools and torques, which are used in removal, disassembly, inspection, reassembly and installation on the following pages, are listed in the charts, below.

SPECIAL SERVICE TOOLS

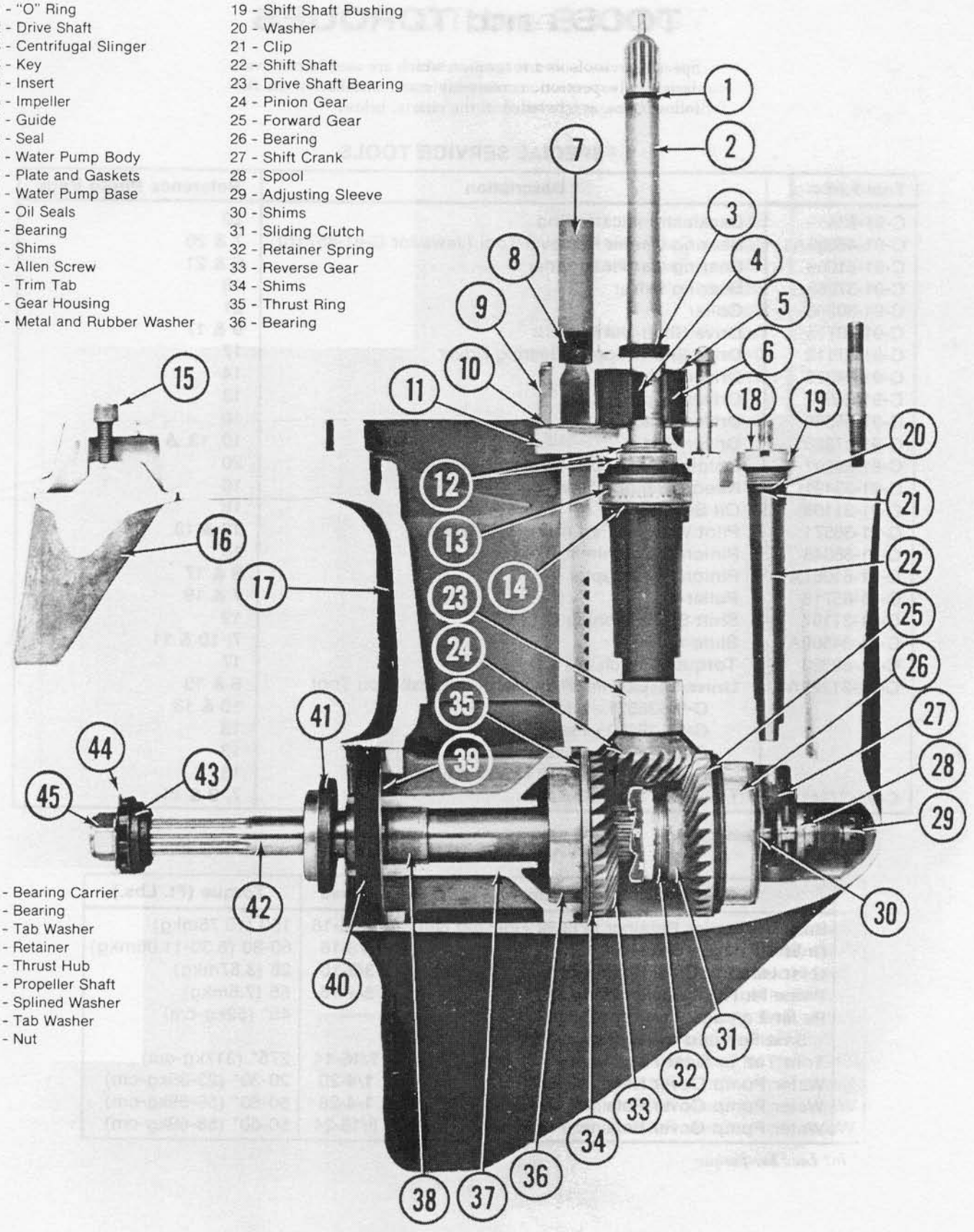
Tool Part No.	Description	Reference Photo Page
C-91-53459	Backlash Indicator Rod	20
C-91-46086A1	Bearing Carrier Removal Tool (Jaws for C-91-85716)	7 & 20
C-91-61069	Bearing Carrier Retainer	6 & 21
C-91-37263	Bearing Driver	18
C-91-30366	Collar	21
C-91-56775	Drive Shaft Nut Wrench	9 & 17
C-91-87119	Drive Shaft Tapered Bearing Driver	17
C-91-34379	Driver Cup	14
C-91-36577	Driver Cup	13
C-91-36569	Driver Head	10
C-91-37323	Driver Rod	10, 13, & 14
C-91-89897	Holding Tool - Dial Indicator	20
C-91-33491	Needle Bearing Driver	16
C-91-31108	Oil Seal Driver	18
C-91-36571	Pilot Washer (Part of C-91-31229A1)	10 & 13
C-91-56048	Pinion Gear Shimming Tool	18
C-91-61067A1	Pinion Nut Adaptor	9 & 17
C-91-85716	Puller Bolt	7 & 19
C-91-31107	Shift Shaft Bushing Tool	12
C-91-34569A1	Slide Hammer	7, 10 & 11
C-91-52523	Torque Wrench (Ft. Lbs.)	17
C-91-31229A1	Universal Bearing Removal and Installation Tool	8 & 13
	C-91-36571 - Pilot	10 & 13
	C-91-29310 - Plate	13
	C-91-38628 - Puller Head	13
	C-91-31229 - Puller Rod and Nut	13
C-91-37241	Universal Puller Plate	7, 9 & 11

TORQUE SPECIFICATIONS

Gear Housing Location	Thread	Torque (Ft. Lbs.)
Bearing Carrier Retainer to Gear Housing Nut	4-3/8-16	150 (19.75mkg)
Drive Shaft Pinion Gear Nut	5/8-18	60-80 (8.30-11.06mkg)
Gear Housing to Drive Shaft Housing Screw	3/8-16	28 (3.87mkg)
Propeller Nut to Propeller Shaft	3/4-16	55 (7.6mkg)
Puller Bolt against Propeller Shaft to Seat Forward Gear Bearing	———	45* (52kg-cm)
Trim Tab to Gear Housing Screw	7/16-14	275* (317kg-cm)
Water Pump Cover Retainer Aft Bolt	1/4-20	20-30* (23-35kg-cm)
Water Pump Cover Retainer Aft Nuts	1/4-28	50-60* (58-69kg-cm)
Water Pump Cover Retainer Forward Nut	5/16-24	50-60* (58-69kg-cm)

** In. Lbs. Torque*

1 - "O" Ring
2 - Drive Shaft
3 - Centrifugal Slinger
4 - Key
5 - Insert
6 - Impeller
7 - Guide
8 - Seal
9 - Water Pump Body
10 - Plate and Gaskets
11 - Water Pump Base
12 - Oil Seals
13 - Bearing
14 - Shims
15 - Allen Screw
16 - Trim Tab
17 - Gear Housing
18 - Metal and Rubber Washer
19 - Shift Shaft Bushing
20 - Washer
21 - Clip
22 - Shift Shaft
23 - Drive Shaft Bearing
24 - Pinion Gear
25 - Forward Gear
26 - Bearing
27 - Shift Crank
28 - Spool
29 - Adjusting Sleeve
30 - Shims
31 - Sliding Clutch
32 - Retainer Spring
33 - Reverse Gear
34 - Shims
35 - Thrust Ring
36 - Bearing



37 - Bearing Carrier
38 - Bearing
39 - Tab Washer
40 - Retainer
41 - Thrust Hub
42 - Propeller Shaft
43 - Splined Washer
44 - Tab Washer
45 - Nut

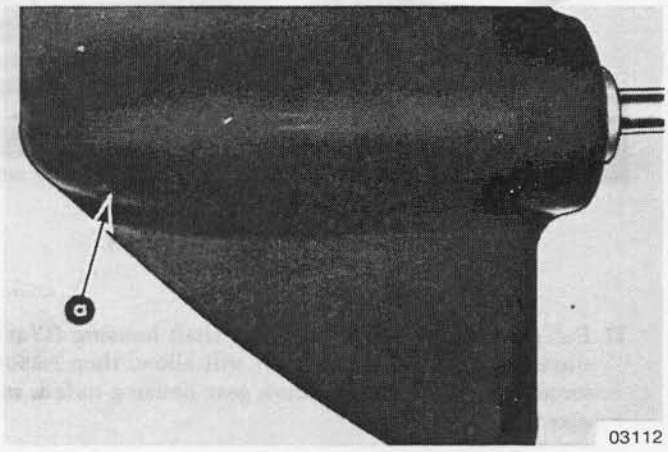
0845

Figure A. I-Drive Gear Housing Assembly

GEAR HOUSING REMOVAL and DISASSEMBLY

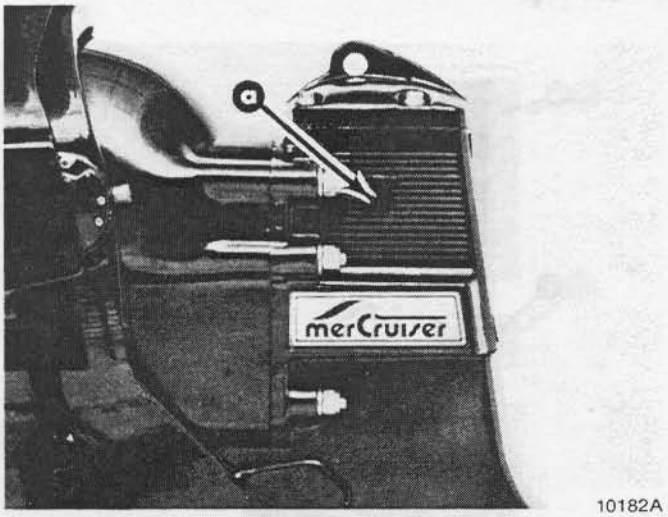
Separating Gear Housing from Drive Shaft Housing

1. Drain lubricant from drive unit by positioning drive unit so that propeller shaft is horizontal, then remove drain plug (Figure 1) and vent plug. (Figure 2)



a - Filler and/or Drain Hole

Figure 1. Drain Plug Location in Gear Housing



a - Oil Vent Plug

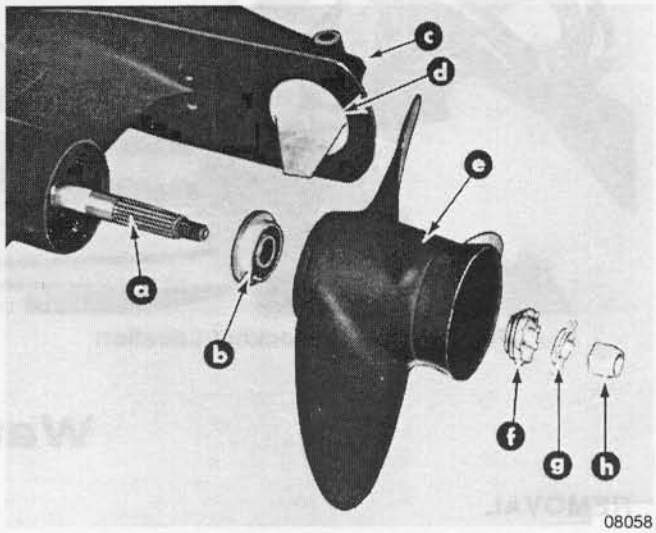
Figure 2. Vent Plug Location in Drive Shaft Housing

NOTE: Vent plug may be located on either side of drive shaft housing.

2. Catch a small amount of gear lubricant on a finger and rub finger and thumb together to check for metal particles.
3. Note the color of the gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant.

CAUTION: If metal particles or water are present in drive unit lubricant, both gear housing and drive shaft housing must be disassembled, cleaned in solvent and closely inspected for damaged oil seals or seal surfaces, "O" rings and cracks in gear housing.

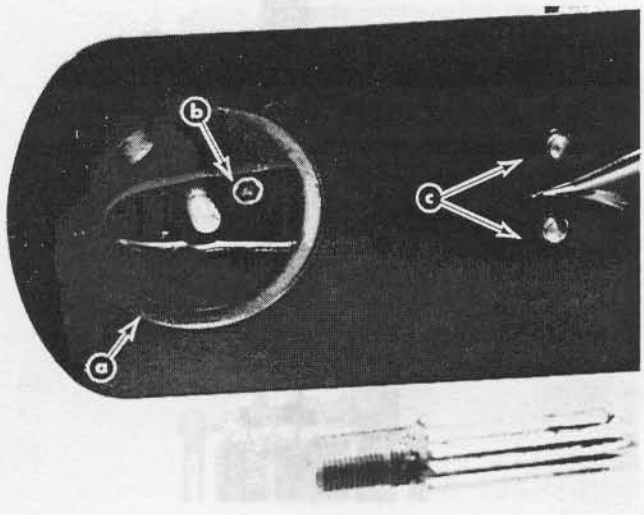
4. Bend tabs of propeller tab washer away from splined washer and place a block of wood between propeller and anti-cavitation plate (to prevent propeller from turning) while turning propeller nut.
5. Remove tab washer, splined washer, propeller and thrust hub. (Figure 3)



a - Propeller Shaft
b - Thrust Hub
c - Plastic Plug
d - Trim Tab
e - Quicksilver Propeller
f - Splined Washer
g - Tab Washer
h - Propeller Nut

Figure 3. Propeller and Trim Tab Removal

6. Mark gear housing and trim tab so that trim tab can be reinstalled in same position. Remove plastic plug from rear edge of drive shaft housing and turn 5/16 allen head screw out of trim tab. (Figure 3)
7. Once trim tab is removed, remove 5/16 allen head screw from inside of trim tab cavity. (Figure 4)



a - Allen Bolt (Secures Trim Tab)
b - Allen Bolt (Inside Trim Tab Cavity)
c - Locknuts

Figure 4. Removing Gear Housing

8. Remove 2 locknuts from bottom center of anti-cavitation plate. (Figure 4)
9. Remove locknut from the front of gear housing mounting stud. (Figure 5)
10. Loosen the side mounting locknuts. (Figure 6) (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or drive shaft housing could be damaged.)

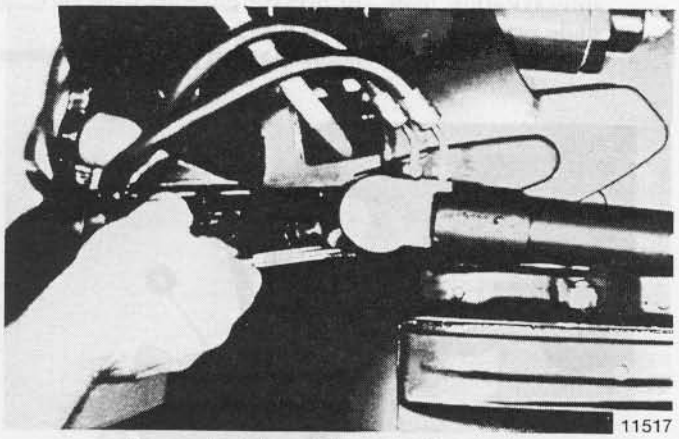
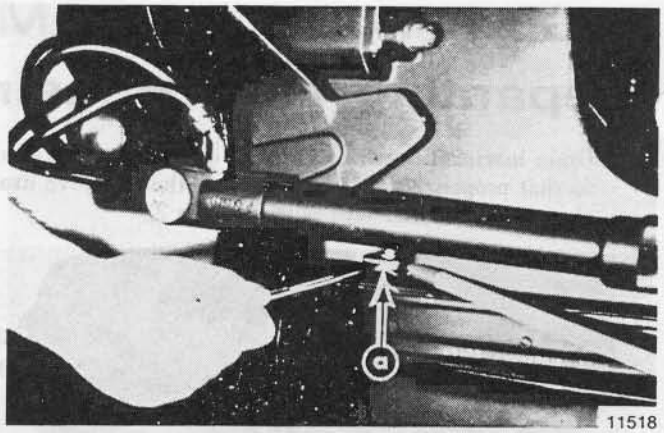


Figure 5. Front Locknut Location



a - Locknut (One on Both Sides)

Figure 6. Side Locknut Location

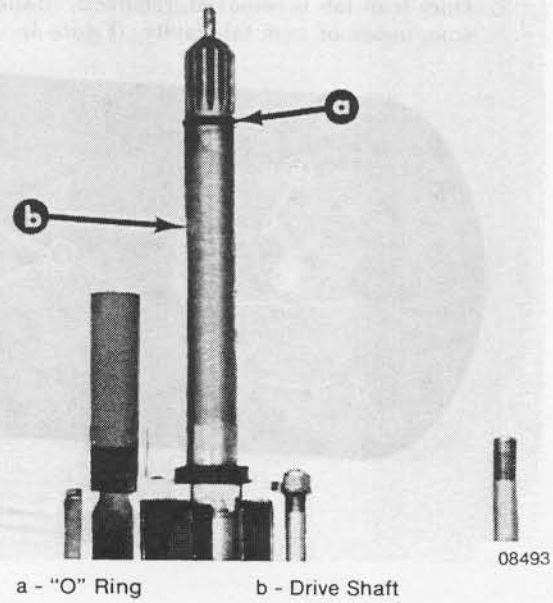
11. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 10) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)

Water Pump

REMOVAL

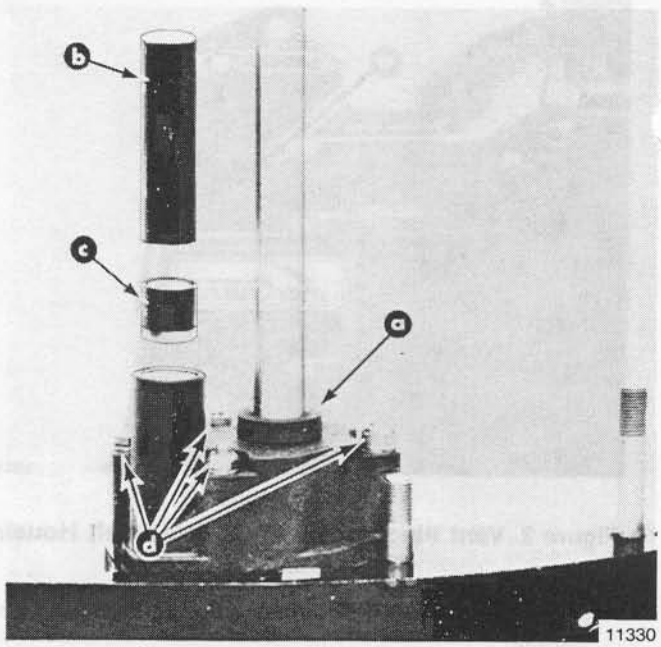
1. Place gear housing in a suitable holding fixture or vise in upright position.
2. Remove "O" ring from upper end of drive shaft (if not already done). (Figure 7)

NOTE: If the "O" ring (located at the top of drive shaft) remains lodged between upper drive shaft seals, be sure to remove "O" ring, or reassembly will be impaired.



a - "O" Ring b - Drive Shaft

Figure 7. Removing Drive Shaft "O" Ring



a - Centrifugal Slinger
b - Water Tube Guide
c - Water Tube Seal
d - Nuts, Bolt and Washers (To Be Removed)

Figure 8. Water Pump Cover Removal

3. Remove rubber centrifugal slinger from drive shaft. (Figure 8)
4. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing. (Figure 8)
5. Using 2 pry bars, positioned as shown in Figure 9, lift water pump cover from drive shaft.

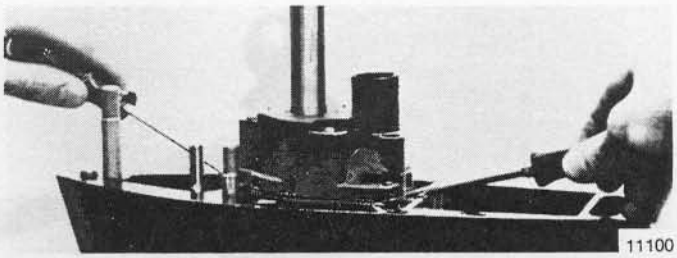
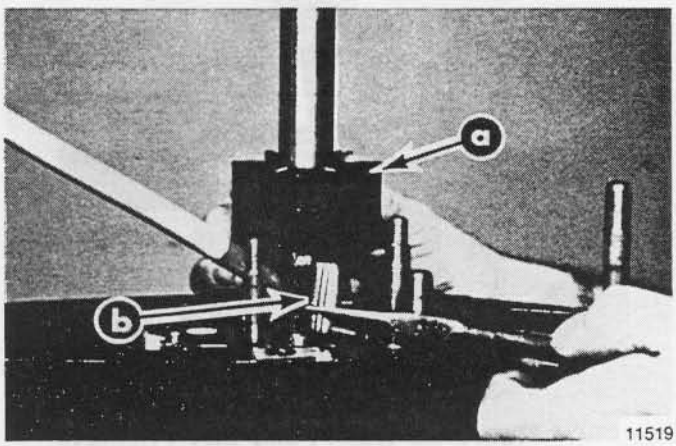


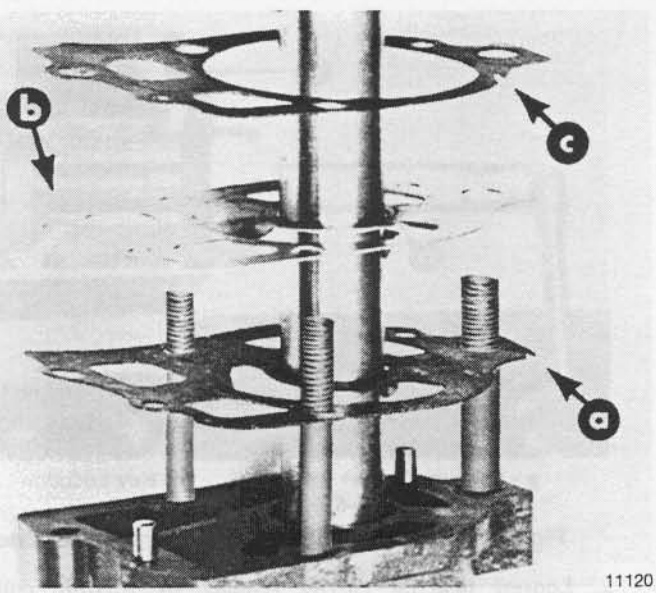
Figure 9. Water Pump Cover Removal



a - Impeller b - Drive Key

Figure 10. Removing Impeller and Drive Key

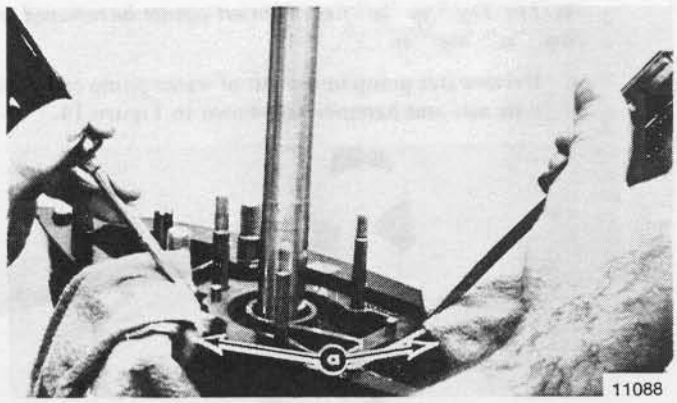
6. Remove impeller from drive shaft. (It may be necessary to use a punch and hammer to drive impeller upward on drive shaft. In extreme cases, it may be necessary to split hub of impeller with hammer and chisel.) (Figure 10)
7. Once impeller is removed, remove impeller drive pin from drive shaft. (Figure 10)
8. Remove water pump face plate and both gaskets (one above and one below face plate) from water pump base.



a - Gasket (Water Pump Base to Face Plate
b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

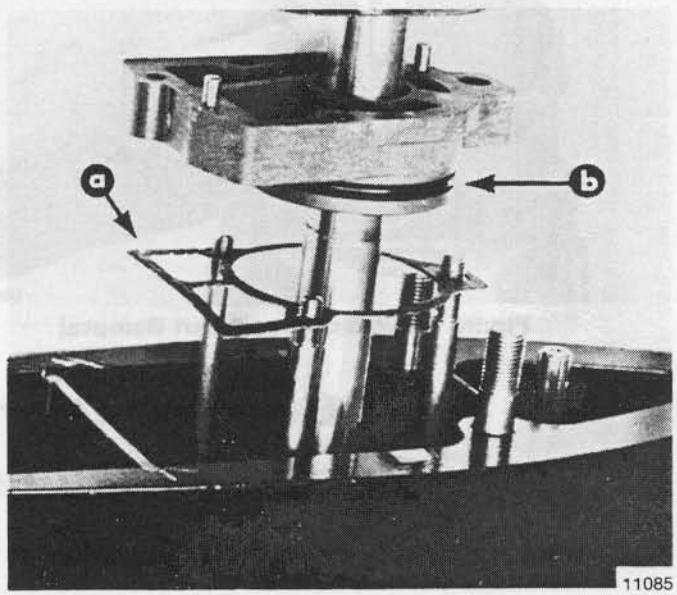
Figure 11. Removing Face Plate and Gaskets

9. Using 2 pry bars, positioned and padded as shown in Figure 12, lift water pump base from drive shaft.
10. Remove pump base to gear housing gasket.



a - Pads

Figure 12. Water Pump Base Removal



a - Gasket b - "O" Ring

Figure 13. Water Pump Base Gasket

CLEANING and INSPECTION

1. Clean metal parts in solvent and dry with compressed air.
2. Check surface of drive shaft where oil seal lips contact shaft. Any groove in drive shaft in this area requires oil seals and shaft replacement.
3. Check water pump impeller for wear on end of impeller blades and on top and bottom edge of blades. Check bonding between hub and impeller. Impellers with blades, that have taken set (hard and deformed), should be replaced.
4. Inspect water pump face plate and insert for roughness and grooves. Replace parts if a defect is found.

DISASSEMBLY

1. Remove water tube guide and seal from water pump body assembly. (Figure 8)
2. Remove oil seals and "O" ring from pump base. (Figure 13)

3. If inspection of water pump insert determines that replacement is required, follow Step "a" or "b" (immediately following) to remove insert from water pump cover.

   NOTE: Try Step "a" first. If insert cannot be removed with Step "a", use Step "b".

   a. Drive water pump insert out of water pump cover with a punch and hammer, as shown in Figure 14.

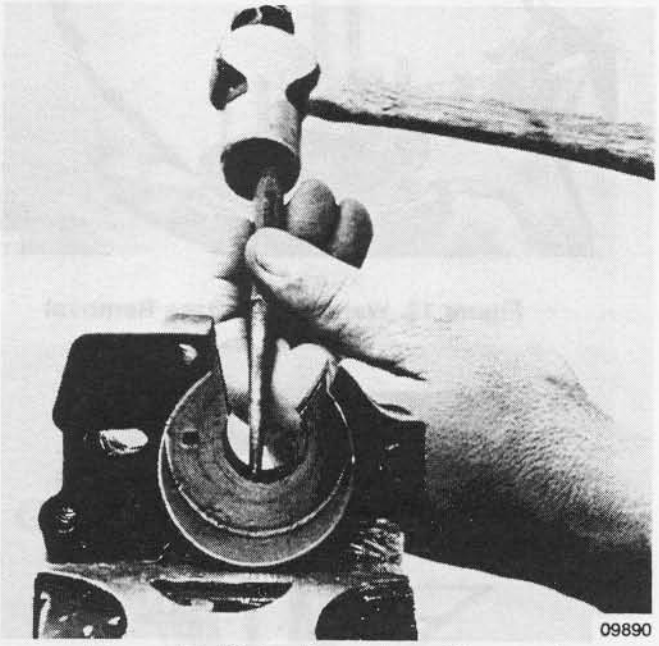
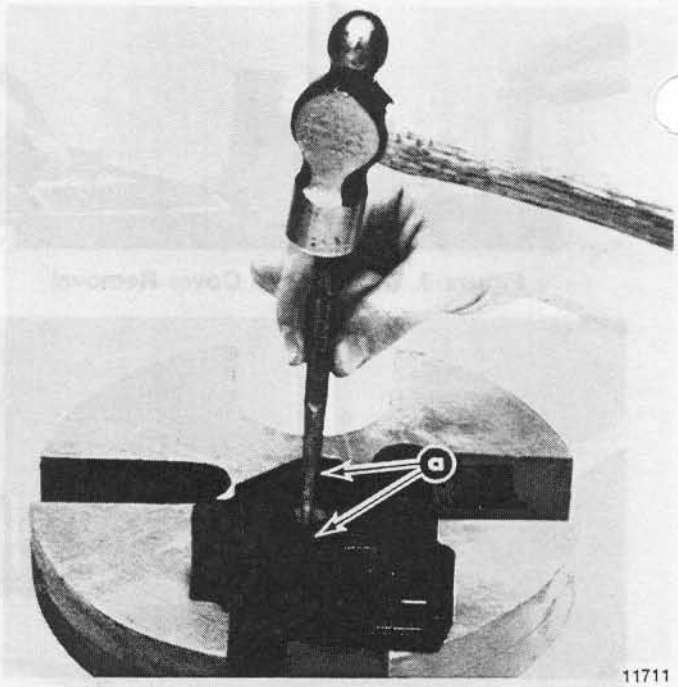


Figure 14. Water Pump Insert Removal



a - Drill 2 Holes at These Locations

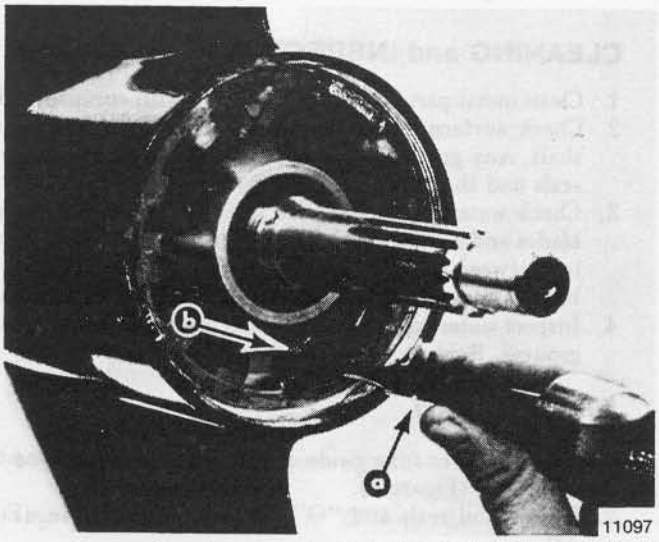
Figure 15. Water Pump Insert Removal

   b. Drill two 3/16" (4.8mm) diameter holes thru the top of water pump cover (but not thru insert) at locations shown in Figure 15. Drive insert out of cover with a punch and hammer, as shown in Figure 15.

Bearing Carrier, Reverse Gear, Carrier Retainer and Tab Washer

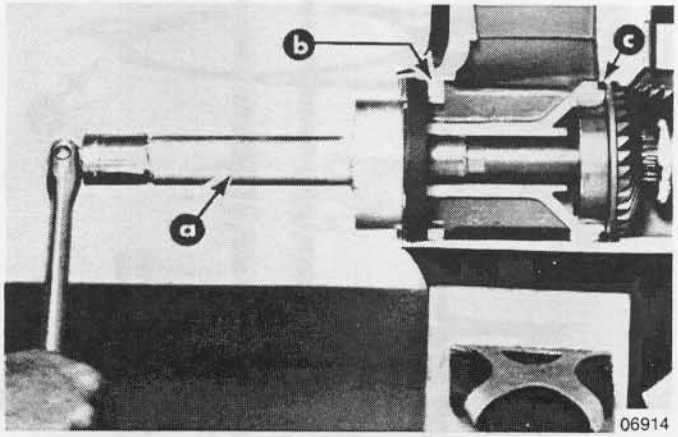
REMOVAL

1. Straighten tab on bearing carrier retainer tab washer. (Figure 16)



a - Punch b - Tab of Tab Washer

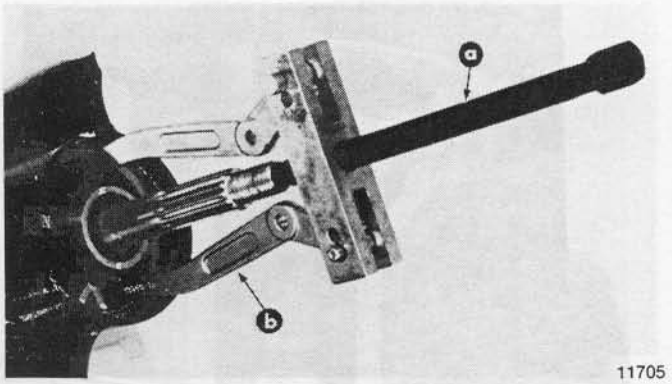
Figure 16. Bending Locktab Away from Cover Nut



a - Bearing Carrier Retainer Wrench (C-91-61069) b - Key Location c - Shims

Figure 17. Removing Bearing Carrier Retainer

2. Loosen bearing carrier retainer by turning counterclockwise with Bearing Carrier Retainer Wrench (C-91-61069). (Figure 17) Remove retainer and tab washer.
3. Use Jaws (C-91-46086A1) with Puller Bolt (C-91-85716) t remove bearing carrier assembly (use bosses that are on the inside hub of bearing carrier to support jaws of puller). (Figure 18)



a - Long Puller Jaws (C-91-46086A1) b - Puller Bolt (C-91-85716)

Figure 18. Removing Carrier

NOTE: When bearing carrier is removed from gear housing, the bearing carrier alignment key (located on top of carrier) will slide out with it. (Figure 17)

4. Remove bearing carrier to gear housing shims. (Figure 17)

CLEANING and INSPECTION

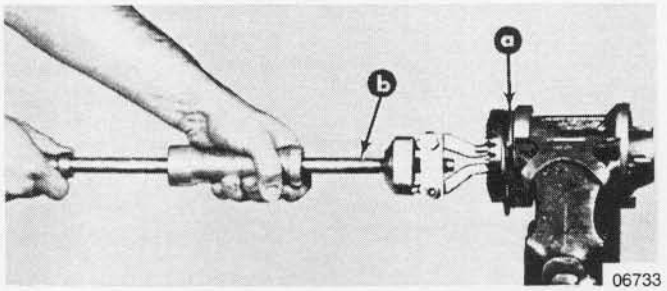
1. Clean parts in solvent and dry with compressed air.
2. Inspect surface of propeller shaft where oil seal lips contact shaft. The presence of a groove in this area of the propeller shaft requires oil seals and shaft replacement.

CAUTION: DO NOT spin bearings with compressed air while drying, as this could cause bearing to score.

3. Apply a very light coat of oil to reverse gear ball bearing. Rotate bearing and check for rough spots. Grasp reverse gear in one hand, bearing carrier in other. Pull-and-push to check for side wear. Any excessive movement is cause for replacement.
4. Check condition of needle bearing by inspecting bearing contact surface on propeller shaft. Pitting, grooves scoring, discoloration from overheating, uneven wear and embedded foreign metal particles are reason for bearing and propeller shaft replacement.
5. Inspect reverse gear for pitting, chipped or broken teeth excessive or uneven wear. Check clutch jaws on reverse gear for damage. Surface must not be chipped or rounded-off.
6. Check threaded retainer for cracks and broken or corroded threads.

DISASSEMBLY

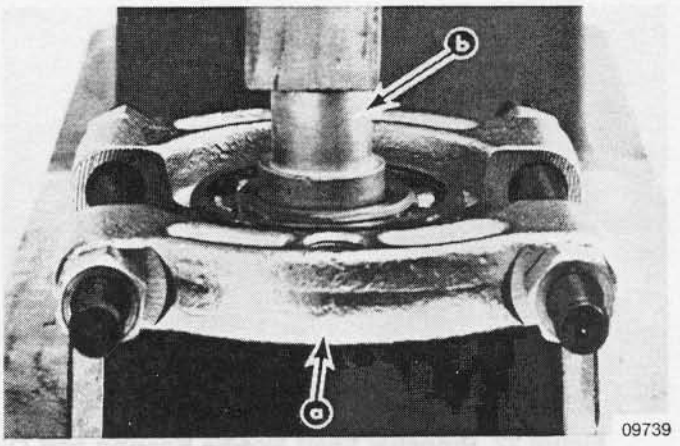
IMPORTANT: Clamp only on reinforcing fin of carrier, or carrier may be damaged.



a - "O" Ring Location b - Slide Hammer C-91-34569A1

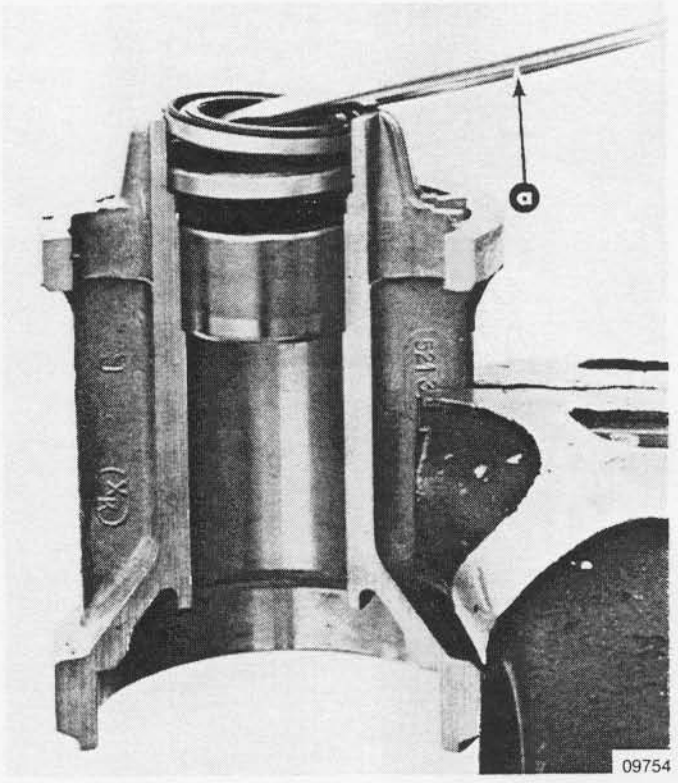
Figure 19. Removing Reverse Gear

1. Remove "O" ring from between bearing carrier and thrust washer. (Figure 19)
2. Position bearing carrier in a soft jaw vise, as shown in Figure 19.
3. Use Slide Hammer (C-91-34569A1), as shown in Figure 19, and remove reverse gear.



a - Universal Puller Plate b - Mandrel

Figure 20. Removing Reverse Gear Bearing from Reverse Gear



a - Pry Bar

Figure 21. Removing Propeller Shaft Oil Seals

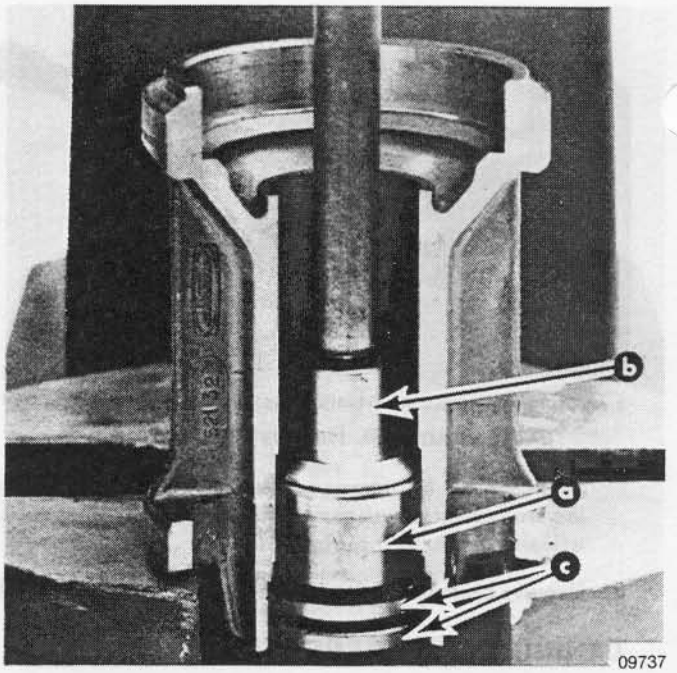
4. Remove ball bearing from reverse gear with Universal Puller Plate (C-91-37241), being sure that gear face is down. (Figure 20)

NOTE: Unless propeller shaft needle bearing is to be replaced (and reverse gear is already removed), do not use Step 5b.

5. Propeller shaft oil seals can be removed either by (a) using a pry bar, as shown in Figure 21 (being careful not to

damage bore), or (b) pressing seals out when propeller shaft needle bearing is pressed out of bearing carrier. (Figure 22)

6. Remove needle bearing, using Universal Bearing Removal and Installation Tool (C-91-31229A1), as shown in Figure 22, to press bearing and seals out of bearing carrier.



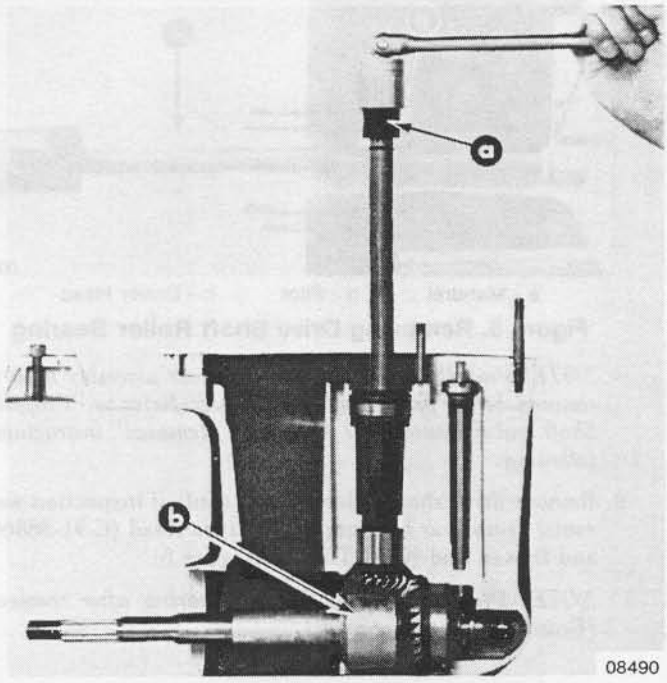
a - Propeller Shaft Needle Bearing
b - Mandrel
c - Oil Seals

Figure 22. Propeller Shaft Needle Bearing and Oil Seals Removal

Drive Shaft and Pinion Gear

REMOVAL

1. Place Drive Shaft Wrench Adaptor (C-91-56775) over drive shaft splines so that total spline area is protected by adaptor. (Figure 1)



a - Drive Shaft Wrench (C-91-56775)
b - Pinion Nut Adaptor (C-91-61067A1)

Figure 1. Loosening Pinion Gear Nut

2. Install Pinion Nut Adaptor (C-91-61067A1) over propeller shaft and onto pinion gear nut. (Figure 1)
3. Turn drive shaft (with adaptor wrench) counterclockwise to remove pinion nut.

NOTE: If drive shaft is broken, place splined hex nut (from tool C-91-61067A1) on propeller shaft in conjunction with Pinion Nut Adaptor and turn propeller shaft counterclockwise to loosen pinion gear nut.

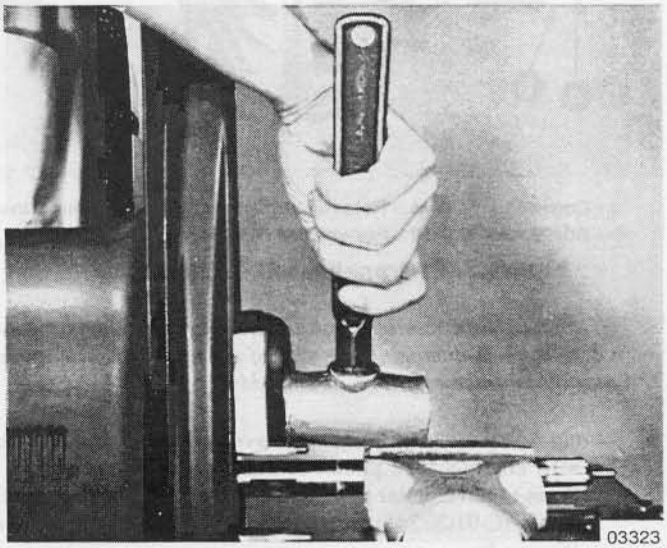


Figure 2. Removing Drive Shaft

4. To remove drive shaft from pinion gear splines, it may be necessary to clamp shaft in vise (using brass jaws) as close to gear housing as possible. Use block of wood to protect gear housing and drive gear from end of drive shaft, as shown in Figure 2.
5. Tip housing down, then tilt propeller shaft toward bottom of housing and allow pinion gear to fall out into the hand. DO NOT allow propeller shaft to fall from gear housing.

CLEANING and INSPECTION

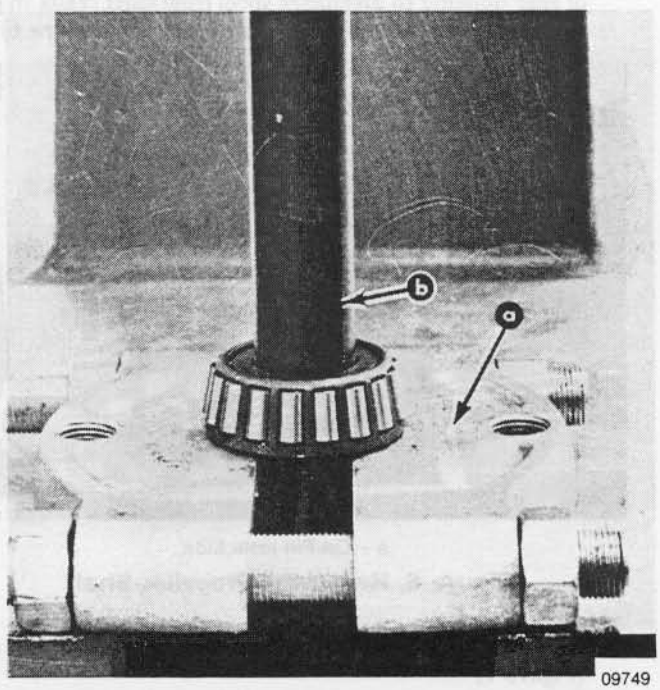
1. Clean pinion gear, drive shaft and drive shaft tapered roller bearing in solvent and dry with compressed air.

CAUTION: DO NOT spin bearing with compressed air while drying, as this could cause bearing to score.

2. Inspect pinion gear for pitting, chipped or broken teeth and excessive or uneven wear.
3. Inspect area of drive shaft where roller bearing rides. Pitting, grooves, scoring, uneven wear, discoloration from overheating and embedded foreign metal particles are causes for drive shaft and roller bearing replacement.
4. Check drive shaft tapered roller bearing by inspecting bearing cup. Replace bearing and bearing cup, if cup is pitted, grooved, scored, worn uneven, discolored from overheating, or if foreign metal particles are embedded in cup.
5. Inspect drive shaft splines (both ends) for wear.
6. Check drive shaft for straightness.

DISASSEMBLY

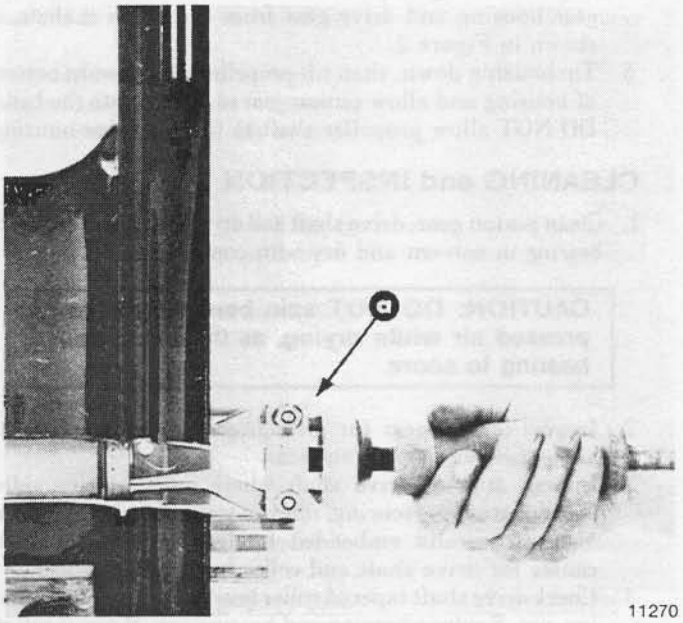
NOTE: To achieve proper support from Universal Puller Plate, it may be necessary to press on the side of the puller plate to separate bearing from shoulder, then finish press as shown in Figure 3.



a - Universal Puller Plate b - Pinion End of Drive Shaft

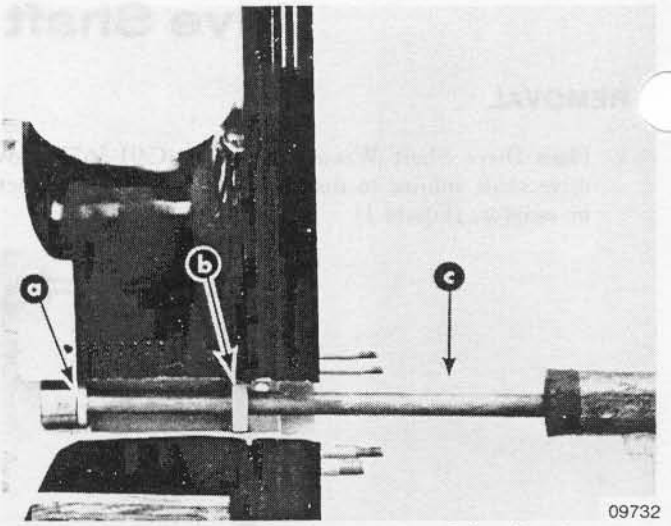
Figure 3. Removing Drive Shaft Tapered Bearing

1. Press tapered roller bearing from drive shaft with Universal Puller Plate (C-91-37241) and arbor press. (Figure 3)
2. Use a Slide Hammer (C-91-34569) to remove drive shaft tapered bearing race from gear housing. (Figure 4) Retain shim(s).



a - Slide Hammer

Figure 4. Drive Shaft Tapered Bearing Cup Removal



a - Mandrel b - Pilot c - Driver Head

Figure 5. Removing Drive Shaft Roller Bearing

NOTE: Propeller shaft and forward gear assembly must be removed before proceeding to next step. Refer to "Propeller Shaft and Forward Gear Assembly - Removal" instructions, following.

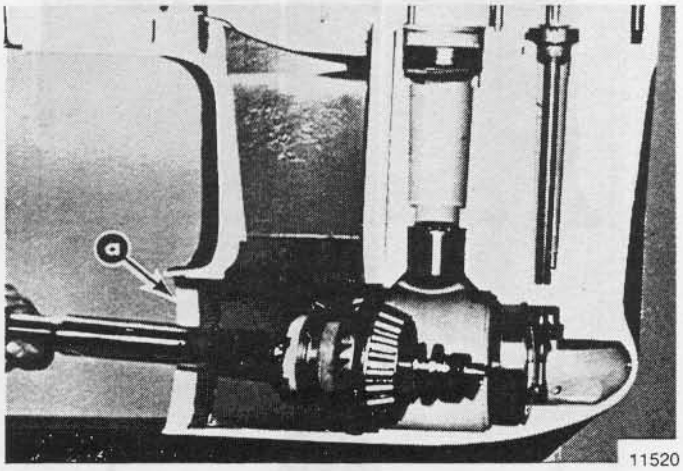
3. Remove drive shaft roller bearing (only if inspection warrants) from gear housing with Driver Head (C-91-36569) and Driver Rod (C-91-37323). (Figure 5)

NOTE: Discard drive shaft roller bearing after removal. (Bearing cannot be re-used.)

Propeller Shaft and Forward Gear Assembly

REMOVAL and DISASSEMBLY

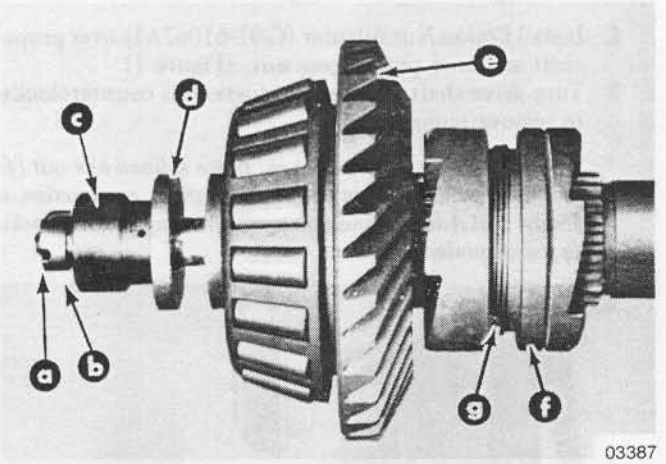
1. Tilt propeller end of propeller shaft toward oil fill hole side of gear housing to disengage spool from shift crank in gear housing, then lift assembly from housing. (Figure 6)



a - Oil Fill Hole Side

Figure 6. Removing Propeller Shaft

2. Remove cotter pin and unscrew adjusting castle nut. (Figure 7)
3. Remove spool assembly and forward gear assembly. (Figure 7)



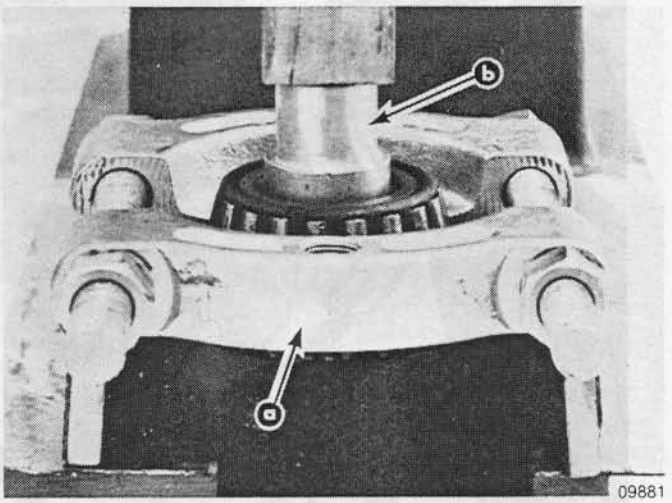
a - Cotter Pin c - Retainer Cap (Spring and Washers Inside)
b - Adjusting Castle d - Forward Gear Assembly

Figure 7. Propeller Shaft Components

NOTE: Disassembly of spool assembly is only recommended when there is damage to any of the components. The spool usually is damaged in disassembly.

4. Clamp spool in vise and remove retainer cup (Figure 7) with channel lock pliers. Remove spring and washer.
5. Press tapered roller bearing from forward gear with Puller Plate (C-91-37241), proper mandrel and arbor press. (Figure 8)

NOTE: To achieve proper support from Universal Puller Plate, it may be necessary to press on the side of the puller plate to separate bearing from shoulder, then finish press as shown in Figure 8.

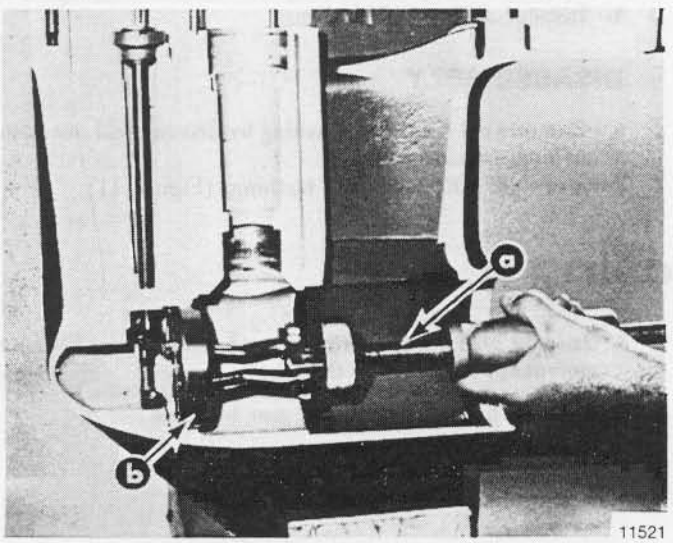


a - Universal Puller Plate b - Mandrel

Figure 8. Removing Tapered Roller Bearing from Forward Gear

NOTE: If replacing the tapered roller bearing, then roller bearing cup also must be removed.

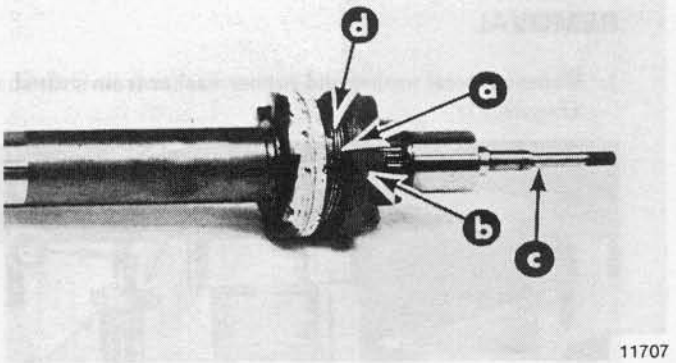
6. Remove forward gear tapered roller bearing cup with Slide Hammer (C-91-34569A1). Remove and retain shims from under cup. (Figure 9)



a - Slide Hammer b - Tapered Bearing Cup

Figure 9. Forward Gear Tapered Bearing Cup Removal

7. Forward gear roller bearing (located on inside diameter of gear) must be broken for removal. Split bearing case with a chisel, then remove bearing.



a - Spring c - Actuating Shaft
b - Sliding Clutch d - Pin Location

Figure 10. Removing Sliding Clutch and Actuating Pin

8. Remove sliding clutch cross pin retaining spring and push cross pin out with a punch. Sliding clutch and clutch actuating shaft now can be removed from propeller shaft. (Figure 10)

CLEANING and INSPECTION

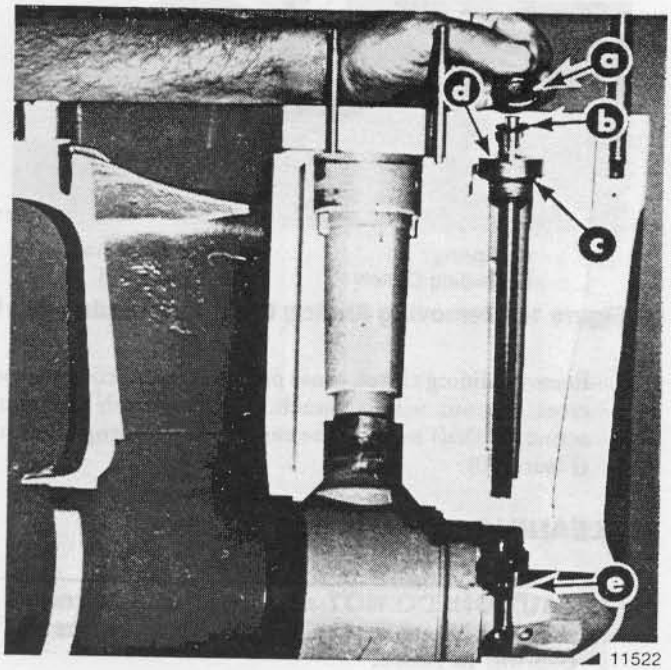
CAUTION: DO NOT spin bearings with compressed air while drying, as this could cause bearing to score.

1. Clean parts in solvent and dry with compressed air.
2. Inspect forward gear for pitting, chipped or broken teeth and excessive or uneven wear. Check forward gear clutch jaws for damage. Jaws must not be chipped or rounded-off.
3. Check sliding clutch engaging jaws for chipped or rounded-off condition. Damaged clutch engaging surface indicates incorrect shift cable adjustments, worn parts or incorrect shifting habits by operator.
4. Check propeller shaft for straightness.
   a. Place propeller shaft on balance wheels. Observe shaft for wobble on propeller end of shaft. Replace if bent.
   b. Place propeller shaft on "V" blocks. Rotate shaft. If propeller end of shaft wobbles, replace shaft.
   c. Place shaft between centers in lathe. Place dial indicator in area of needle bearing. If total indicator variation is greater than .005" (.13mm) as shaft is revolved, replace shaft.
5. Clean all corrosion from propeller shaft splines with wire brush. If splines are partially corroded away, replace shaft.
6. To inspect forward gear roller bearing (located on inside diameter of gear), gear must be removed from propeller shaft assembly. Inspect area of propeller shaft where roller bearing rides. Pitting, grooves, scoring, uneven wear, discoloration from overheating and embedded foreign metal particles are all reasons for replacement of propeller shaft and bearing.
7. Check shift spool for wear.

Shift Shaft

REMOVAL

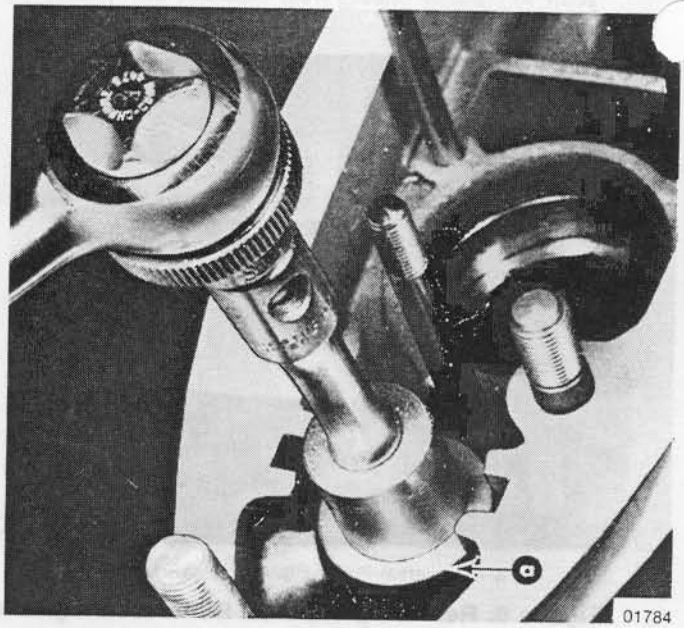
1. Remove metal washer and rubber washer from shift shaft. (Figure 11)



a - Metal Washer
b - Rubber Washer
c - "O" Ring
d - Oil Seal (Inside)
e - Shift Crank

Figure 11. Shift Shaft Washer Locations

2. Use Shift Shaft Bushing Tool (C-91-31107) to remove shift shaft bushing. (Figure 12)
3. Shift shaft now can be pulled out of gear housing.
4. Shift crank now is loose in gear housing and can be removed from its locating pin. (Figure 11)



a - Shift Shaft Bushing Tool (C-91-31107)

Figure 12. Removing Shift Shaft Bushing

CLEANING and INSPECTION

1. Clean parts in solvent and dry with compressed air.
2. Inspect shift shaft splines (where it engages upper shift shaft) for wear and corrosion.
3. Inspect shift shaft bushing for corrosion damage.
4. Inspect shift crank for wear.

DISASSEMBLY

1. Remove oil seal from bushing by driving seal out thru top of bushing. (Figure 11)
2. Remove "O" ring from bushing. (Figure 11)

Gear Housing

1. Clean assembly in solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Inspect for loose fitting bearings or bearing cups and for signs that bearing cups or bearings have spun in their sets.
4. Inspect bearing carrier retainer threads in gear housing for corrosion or stripped threads.
5. Inspect painted surface of gear housing.

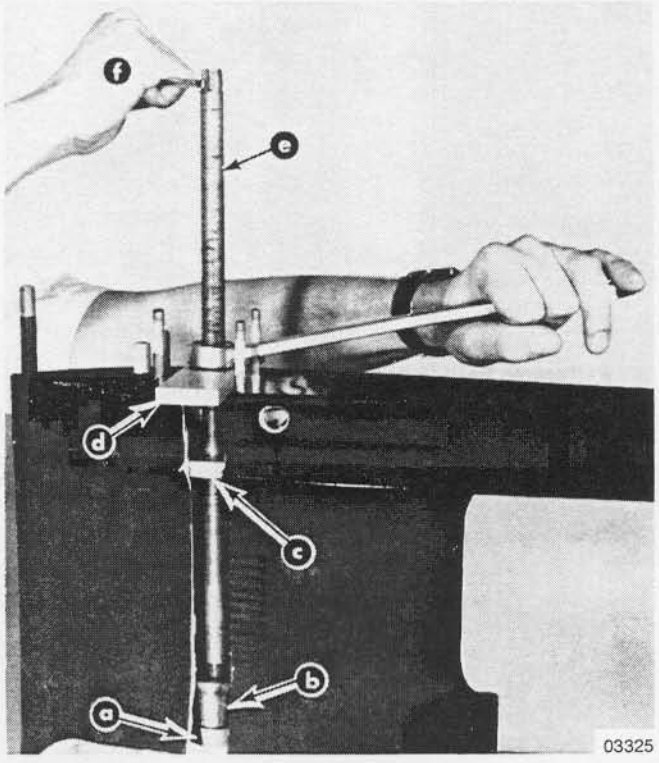
GEAR HOUSING REASSEMBLY and INSTALLATION

Roller Bearing (Drive Shaft) and Bearing Cups (Drive Shaft and Forward Gear)

INSTALLATION

CAUTION: If drive shaft roller bearing failure has occurred, and original bearing case has turned in gear housing, gear housing must be replaced. Loose fitting roller bearings will move out of position and cause repeated failures.

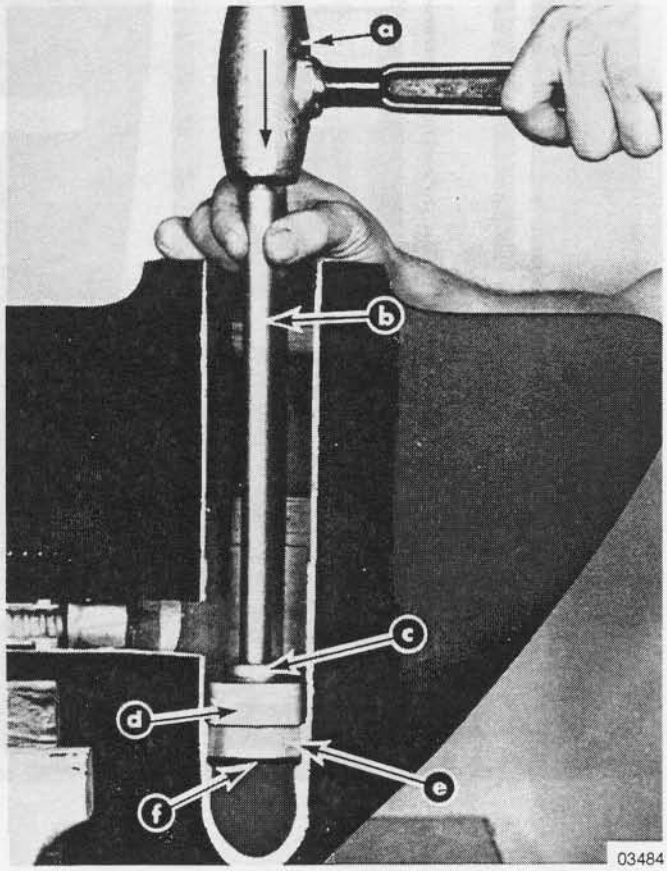
1. Apply thin coat of Universal Joint Lubricant [from U-Joint Grease Kit (C-91-74057A1)] to drive shaft needle bearing bore in gear housing. (Figure 1)



a - Puller Head
b - Bearing (Numbered Side Up)
c - Pilot
d - Plate
e - Puller Rod
f - Hold

Figure 1. Installing Drive Shaft Roller Bearing

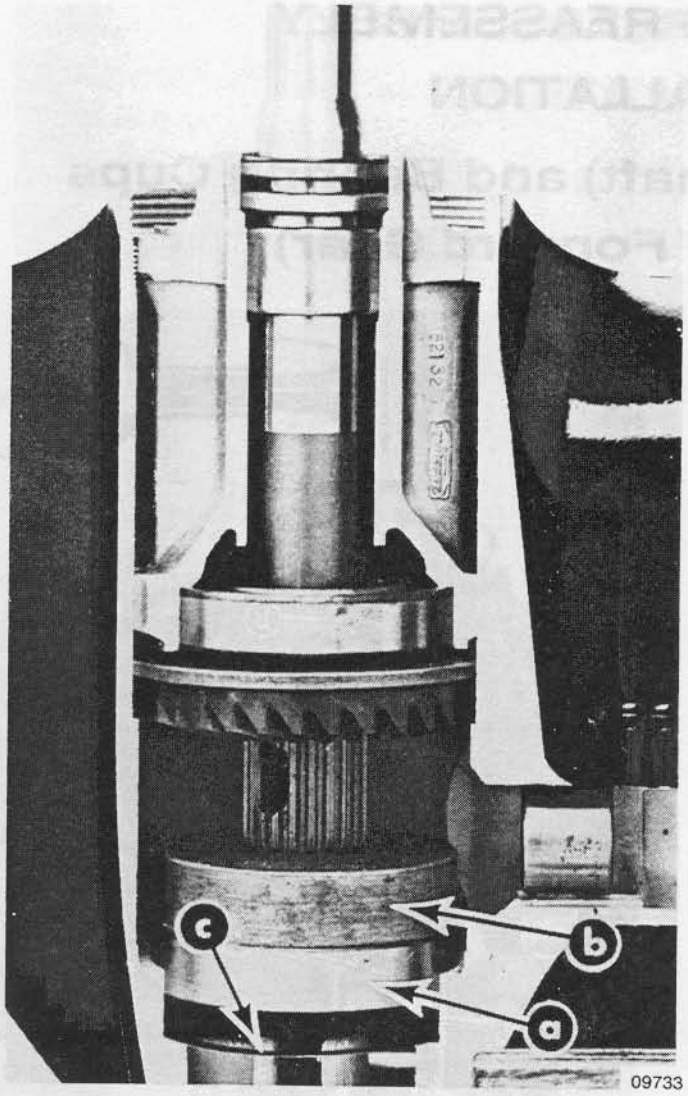
2. By way of propeller shaft cavity, place needle bearing in drive shaft bore (with numbered side of bearing facing up drive shaft bore). (Figure 1)
3. Install and seat roller bearing with the following tools: Puller Rod and Nut (C-91-31229), Pilot (C-91-36571), Plate (C-91-29310) and Puller Head (C-91-38628). Pull bearing up into bore until it bottoms on gear housing shoulder. (Figure 1)



a - Lead Hammer
b - Drive Rod
c - Adaptor
d - Driver Cup
e - Bearing Cup
f - Shims

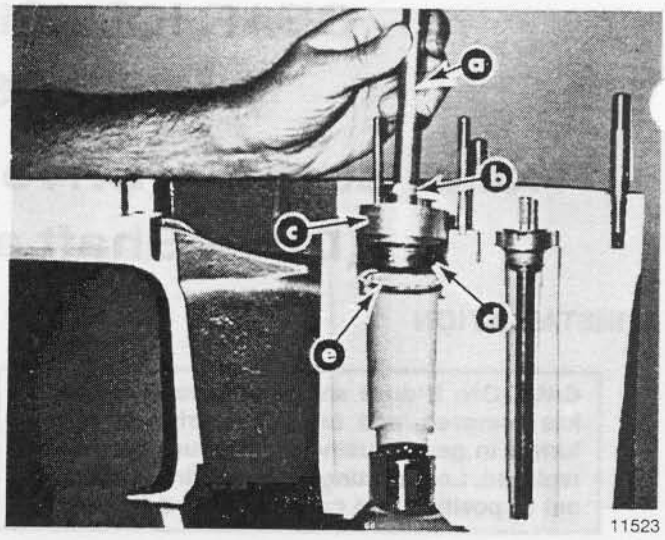
Figure 2. Installing Forward Gear Bearing Cup

4. Place forward gear bearing cup shim(s) (retained from disassembly) into gear housing. If shim(s) were lost or a new gear housing is being used, start with approximately .010" (0.25mm). (Figure 2)
5. Apply a light coat of Universal Joint Lubricant to forward gear bearing race bore in gear housing.
6. Position forward gear tapered bearing race squarely over bearing bore in front portion of gear housing.
7. Install cup with Driver Cup (C-91-36577), Driver Rod (C-91-37323) and Adaptor (C-91-36569), as shown in Figure 2. If old propeller shaft is available, use in conjunction with bearing carrier to install bearing. (Figure 3)
8. Install drive shaft tapered roller bearing cup and shim(s) in same manner as forward gear bearing cup. Use Driver Cup (C-91-34379), Drive Rod (C-91-37323) and Adaptor (C-91-36569). (Figure 4) If beginning with new gear housing, or shim(s) were lost, then start with .015" (0.38mm) shim thickness.



a - Tapered Bearing Race b - Bearing Driver c - Shims

Figure 3. Installing Forward Gear Bearing Cup



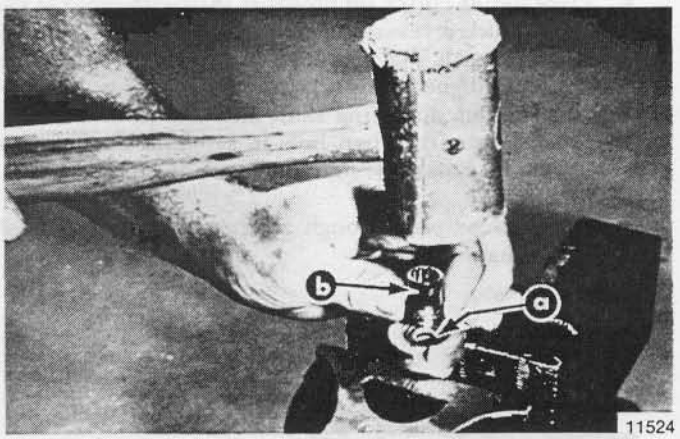
a - Drive Rod c - Drive Cup e - Shims
b - Adaptor d - Bearing Cup

Figure 4. Installing Drive Shaft Tapered Roller Bearing

Shift Shaft Assembly

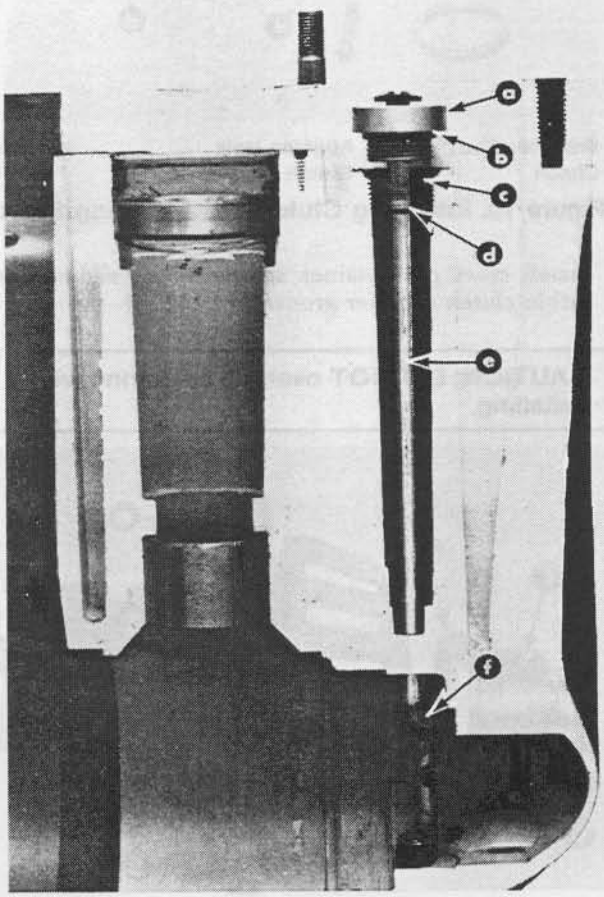
REASSEMBLY

1. Install oil seal in shift shaft bushing with lip facing up. (Figure 5)
2. Install "O" ring on shift shaft bushing. (Figure 6)
3. Place clip in groove on shift shaft. (Figure 6)



a - Seal b - Appropriate Mandrel

Figure 5. Installing Seal in Shift Shaft Bushing

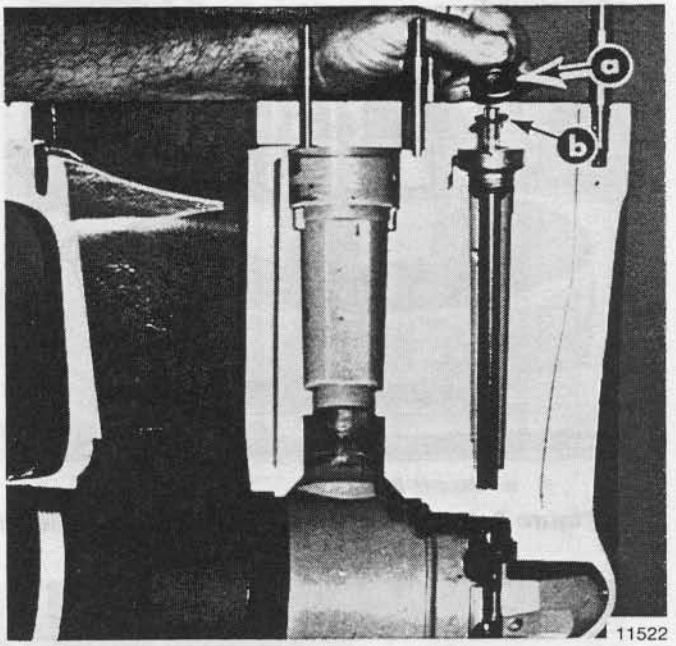


a - Bushing
b - "O" Ring
c - Washer
d - Clip
e - Shift Shaft
f - Shift Crank

Figure 6. Shift Shaft Installation

INSTALLATION

1. Set shift crank on locating pin with "throw" side of crank facing oil fill side of gear housing. (Figure 6)
2. Install shift shaft (with retaining clip) into gear housing, engaging it into the splines of the shift actuating crank. (Figure 6)
3. Place retaining washer over shift shaft on top side of retaining clip. (Figure 6)
4. Lubricate lip of shift shaft bushing oil seal and bushing "O" ring with Universal Joint Lubricant [from U-Joint Grease Kit (C-91-74057A1)] to ease installation. Install shift shaft bushing to gear housing and tighten securely with Shift Shaft Tool (C-91-31107).
5. Place rubber washer and upper metal washer on shift shaft. Use Universal Joint Lubricant to hold metal washer in place until gear housing installation is made. (Figure 7)



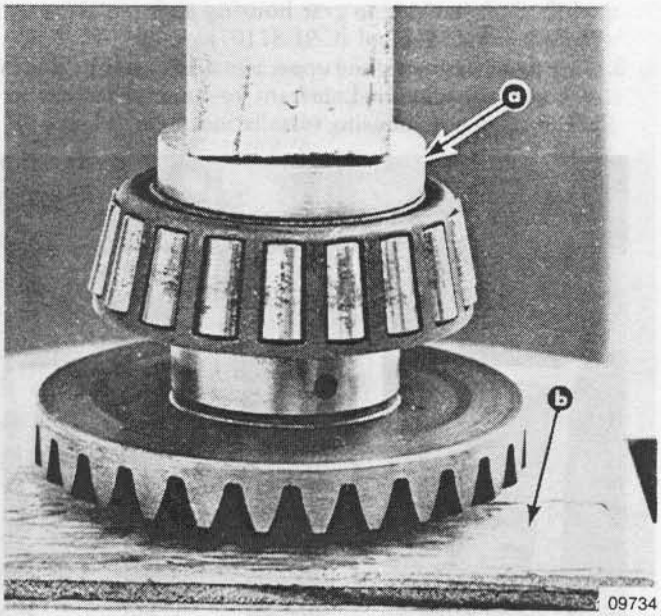
a - Metal Washer b - Rubber Washer

Figure 7. Shift Shaft Metal Washer and Rubber Washer Location

Propeller Shaft and Forward Gear Assembly

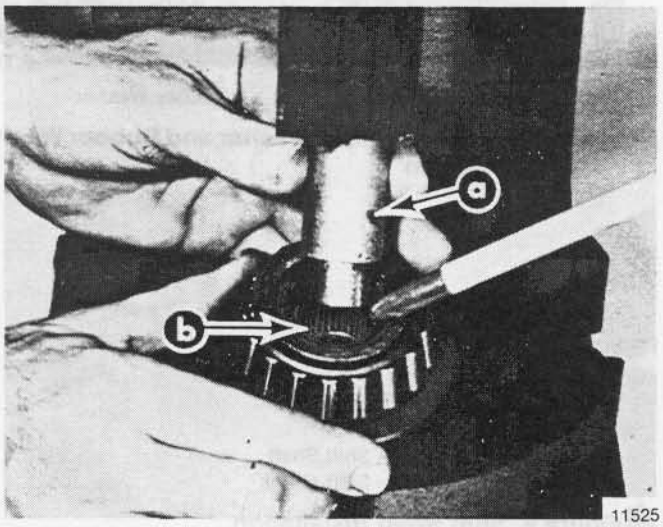
REASSEMBLY

1. Place forward gear on a press with teeth down. Apply a thin coat of Universal Joint Lubricant [from U-Joint Grease Kit (C-91-74057A1)] to inner bore of bearing, then press forward gear tapered roller bearing onto forward gear, using Adaptor (C-91-36571) (or proper adaptor) and applying pressing force on center race of bearing. Seat bearing against shoulder of gear. (Figure 8)



a - Proper Adaptor b - Wood Block

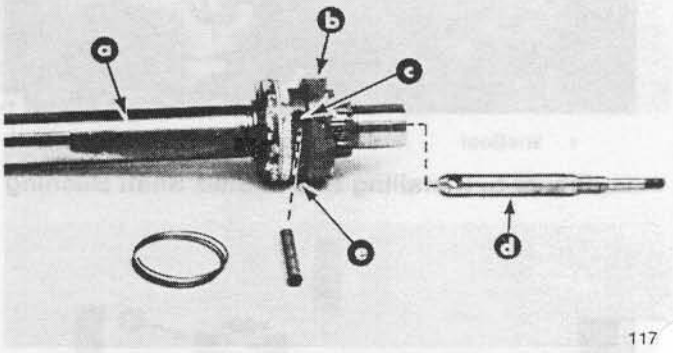
Figure 8. Installing Forward Gear Tapered Roller Bearing



a - Appropriate Tool b - Numbered Side of Needle Bearing

Figure 9. Forward Gear Needle Bearing Installation

2. Apply a light coat of Universal Joint Lubricant to bore in center of forward gear.
3. Install forward gear needle bearing into center bore of forward gear (lettered side up), using Needle Bearing Driver (C-91-33491) or proper adaptor and arbor press. Press bearing down into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.) (Figure 9)
4. Place sliding clutch on propeller shaft with grooved end of clutch toward reverse gear end of shaft. Position splines in clutch with shaft so that cross pin holes in clutch and shaft are aligned. (Figure 10)
5. Insert clutch actuating shaft into hole (located in end of propeller shaft). Align hole in actuating shaft to match cross pin holes in sliding clutch and propeller shaft. (Figure 10)
6. Install cross pin through sliding clutch, propeller shaft and actuating shaft.

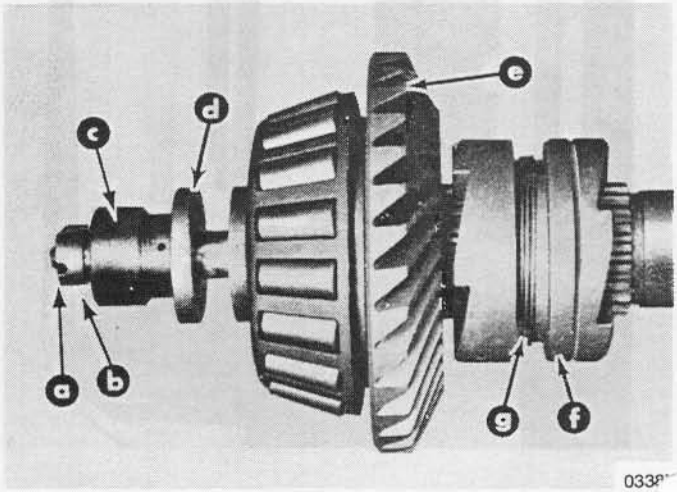


a - Propeller Shaft
b - Clutch
c - Aligning Hole
d - Clutch Actuating Shaft
e - Groove

Figure 10. Installing Clutch and Actuating Shaft

7. Install cross pin retainer spring around sliding clutch within clutch retainer groove. (Figure 11)

CAUTION: DO NOT over-stretch spring when installing.



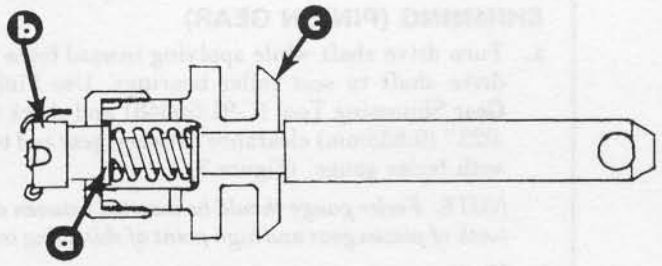
a - Cotter Pin
b - Castle Nut
c - Retainer (Spring and Washer Inside)
d - Spool
e - Forward Gear Assembly
f - Clutch
g - Spring

Figure 11. Propeller Shaft Components

8. Install forward gear and bearing assembly on propeller shaft with gear facing sliding clutch. (Figure 11)
9. Place first washer, spring and second washer into shift actuating spool, then thread on retainer and tighten. (Figure 11)
10. Slide spool assembly over clutch actuating shaft (Figure 11) and thread adjusting castle nut onto shaft until bottom of the castle nut just touches washer and slight resistance is felt. (Figure 12) Back off sleeve until next cotter pin slot is aligned with hole in shaft. Install cotter pin. (Figure 11) Spool MUST spin freely on shaft. DO NOT over-tighten adjusting castle nut, or the purpose of the spring is defeated.

INSTALLATION

Install propeller shaft assembly into gear housing by tilting propeller end of propeller shaft toward oil fill hole side of gear housing. This will allow engagement of shift actuating shaft



a - DO NOT Tighten Castle Past This Point so That Spring Will Not Become Compressed
b - Castle Nut
c - Spool

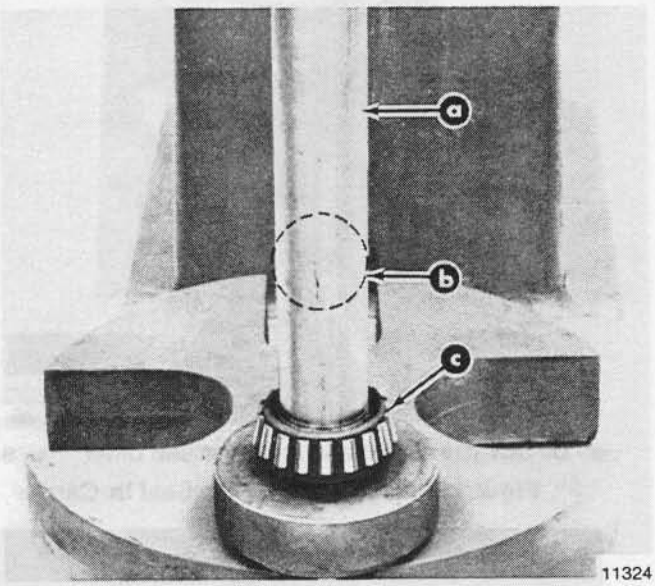
Figure 12. Section View of Spool Assembly

spool with shift crank. Straighten propeller shaft in housing, then operate shift shaft to assure proper installation. Installation is correct when sliding clutch ONLY moves when shift shaft is turned.

Drive Shaft and Pinion Gear

REASSEMBLY

1. Apply a light coat of Universal Joint Lubricant [from U-Joint Grease Kit (C-91-74057A1)] onto the inside diameter of drive shaft tapered bearing. (Figure 1)



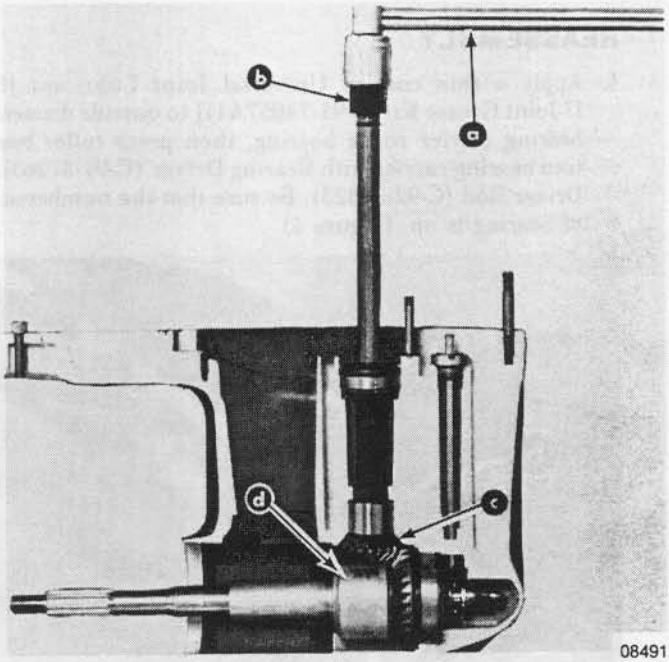
a - Drive Shaft Tapered Bearing Driver (C-91-87119)
b - Pinion Gear End of Drive Shaft
c - Bearing

Figure 1. Drive Shaft Tapered Bearing Installation

2. Position drive shaft tapered bearing over pinion gear end of drive shaft with tapered end of bearing toward pinion end of drive shaft. (Figure 1)
3. Use Drive Shaft Tapered Bearing Driver (C-91-87119) or adequate pipe (which applies pressing force on center bearing race) to press bearing on shaft. (Figure 1)

INSTALLATION

1. Position pinion gear in gear housing below drive shaft bore with teeth of pinion gear meshed with teeth of forward



a - Torque Wrench
b - Drive Shaft Wrench
c - Pinion Gear
d - Pinion Nut Adaptor

Figure 2. Installing Pinion Gear

gear. (Figure 2)
2. Insert drive shaft into drive shaft bore while holding pinion gear as described in Step 1. Rotate drive shaft to align and engage drive shaft splines with pinion gear splines.
3. Install pinion gear nut, using Pinion Nut Adaptor (C-91-61067A1) to assist in holding nut in position under drive shaft. Turn drive shaft to secure nut. (Figure 2)
4. Install Drive Shaft Wrench (C-91-56775) to drive shaft and torque pinion gear nut to specifications (Figure 2), then check and correct, if necessary, pinion gear depth, as follows:

SHIMMING (PINION GEAR)

a. Turn drive shaft while applying inward force on drive shaft to seat roller bearings. Use Pinion Gear Shimming Tool (C-91-56048) and check for .025" (0.635mm) clearance between gear and tool with feeler gauge. (Figure 3)

NOTE: Feeler gauge should be inserted between one tooth of pinion gear and high point of shimming tool.

b. If clearance is not correct, remove pinion gear, drive shaft and bearing cup. If clearance is over .025", remove appropriate thickness of shim; if under, add appropriate shim. (Figure 3) If clearance is correct, continue gear housing reassembly.

a - Feeler Gauge
b - Shimming Tool
c - Obtain .025" Clearance between Tool and Gear
d - Add or Subtract Shims
e - Push

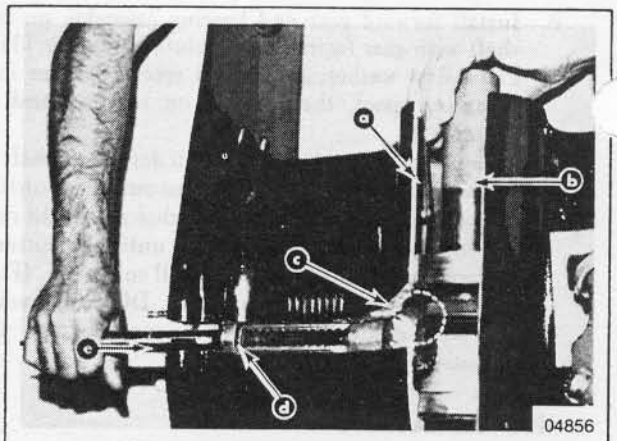


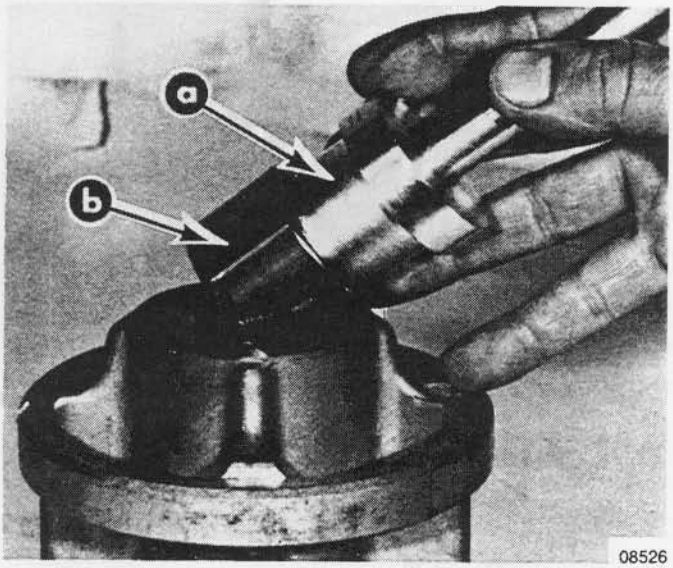
Figure 3. Shimming Procedure

5. Remove pinion gear nut, then reinstall after applying Loctite Type "A" to threads of pinion nut.

Bearing Carrier, Reverse Gear, Carrier Retainer and Tab Washer

REASSEMBLY

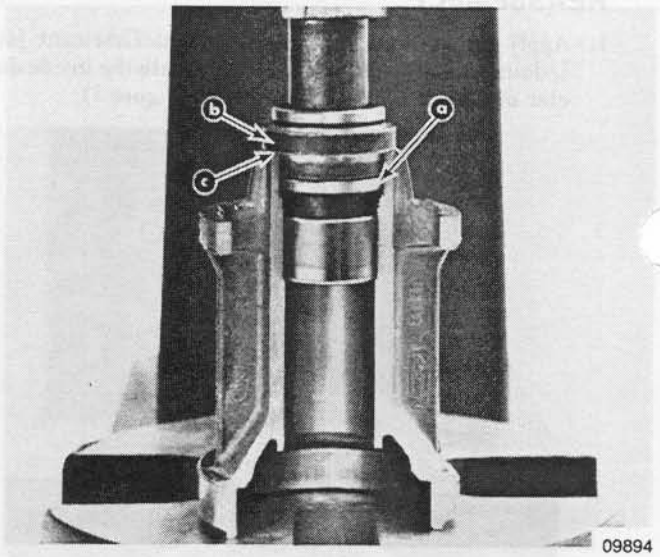
1. Apply a thin coat of Universal Joint Lubricant [from U-Joint Grease Kit (C-91-74057A1)] to outside diameter of bearing carrier roller bearing, then press roller bearing into bearing carrier with Bearing Driver (C-91-37263) and Driver Rod (C-92-37323). Be sure that the numbered side of bearing is up. (Figure 4)



a - Tool (C-91-37263)
b - Roller Bearing

Figure 4. Installing Roller Bearing in Carrier

2. Apply Loctite Type "A" to outer diameter of propeller shaft oil seals.
3. Place one seal on longer shoulder side of Oil Seal Driver (C-91-31108) with lip of seal away from shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier. (Figure 5)



a - Oil Seal (Lip of Seal Down)
b - Oil Seal Driver
c - Seated

Figure 5. Installing First Oil Seal in Carrier

a - Oil Seal (Lip of Seal Up)
b - Oil Seal Driver
c - Seated

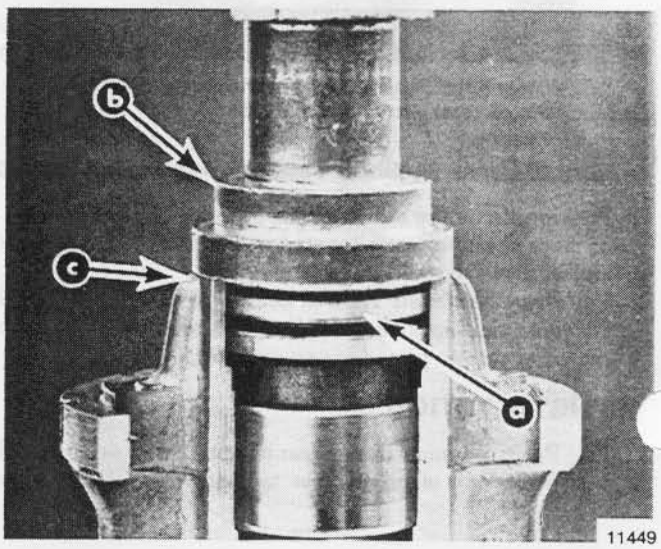
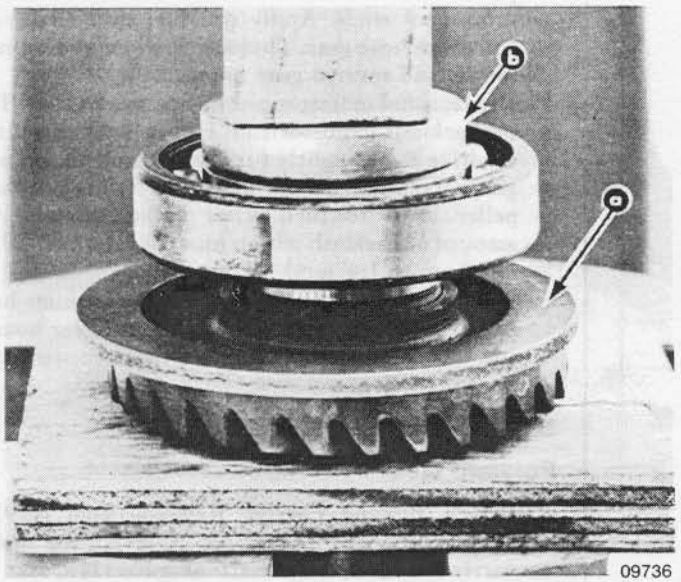


Figure 6. Installing Second Seal in Carrier

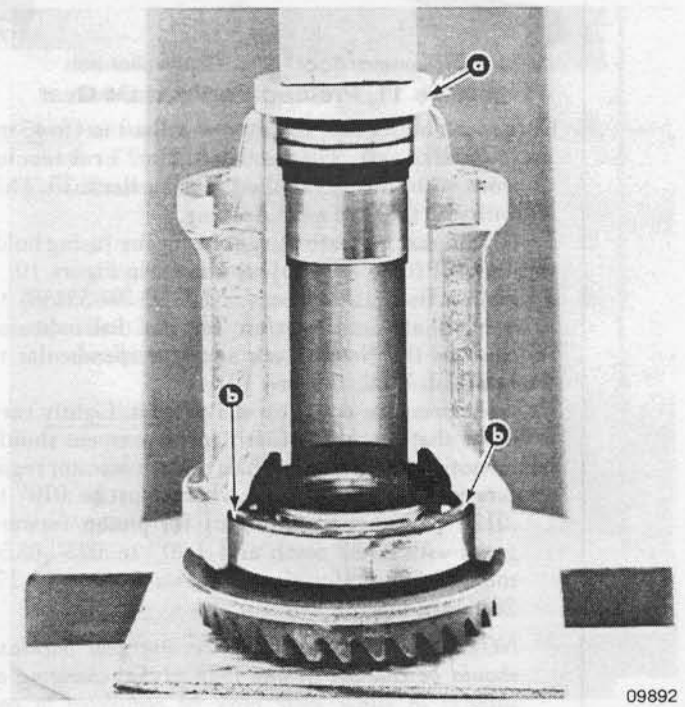
4. Place second seal on short shoulder side of seal driver with lip of seal toward shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier. (Figure 6)
5. Wipe off excess Loctite, then fill area between oil seals with Universal Joint Lubricant.
6. Apply a light coat of Universal Joint Lubricant onto inside diameter of reverse gear ball bearing. (Figure 7)



a - Thrust Washer b - Pilot Washer

Figure 7. Reverse Gear Bearing Installation

7. Install reverse gear ball bearing and thrust washer onto reverse gear with beveled side of thrust washer toward reverse gear. Use Pilot Washer (C-91-36571) to press bearing onto reverse gear. (Be sure to press only on inner race of bearing.) (Figure 7)
8. Apply a light coat of Universal Joint Lubricant to outside diameter of reverse gear ball bearing and place bearing carrier over reverse gear and bearing assembly. Press bearing carrier onto bearing. (Figure 8)
9. Install large "O" ring over bearing carrier in between thrust washer and carrier housing.

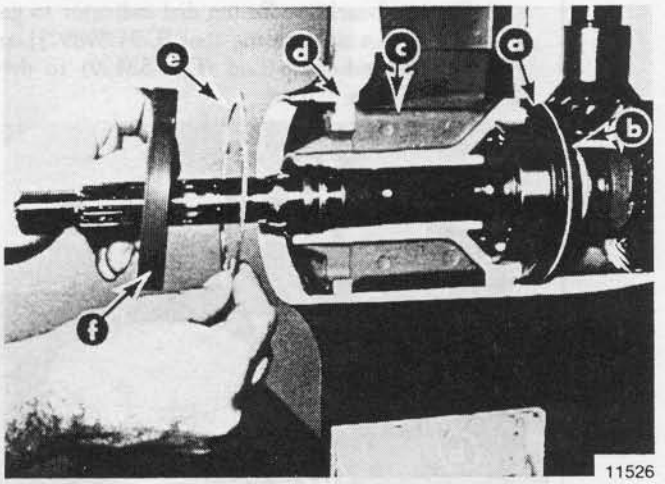


a - Pilot Washer b - Seated

Figure 8. Installing Bearing Carrier onto Reverse Gear

INSTALLATION

1. Lubricate carrier "O" ring with Universal Joint Lubricant. (Figure 9)



a - "O" Ring c - Bearing Carrier e - Tab Washer
b - Shim Location d - Key Location f - Retainer

Figure 9. Installing Bearing Carrier

2. Replace shim(s) (retained from disassembly) into gear housing. If shim(s) were lost, or a new gear housing is being used, start with approximately .020" (0.51mm) thickness of shim. (Figure 9)

IMPORTANT: On final installation of bearing carrier (after forward and reverse gear backlash have been corrected), apply Perfect Seal liberally to outer diameters of carrier which contact gear housing. Surfaces must be clean and oil-free. DO NOT allow sealer to enter ball bearing or reverse gear. Also liberally apply sealer to threads in gear housing before installing retainer.

3. Place bearing carrier assembly into gear housing and push down to seat carrier on shim(s). It may be necessary to turn drive shaft to align teeth of pinion and reverse gears.
4. Place key in bearing carrier to gear housing keyway. (Figure 9)
5. Install bearing carrier retainer tab washer, aligning tab washer "V" tab with "V" notch on bearing carrier (Figure 9).
6. Thread bearing carrier retainer into gear housing and torque to specifications in clockwise direction with Bearing Carrier Retainer Wrench (C-91-61069), then check and correct, if necessary, forward and reverse gear backlash, following.

NOTE: DO NOT secure carrier retainer with tab washer until forward and reverse gear backlash have been checked and corrected, as explained in information immediately following.

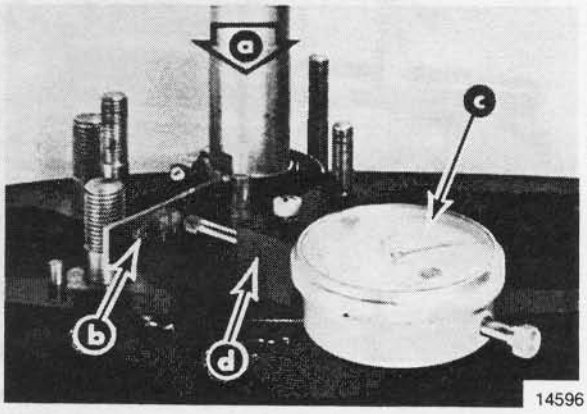
SHIMMING (FORWARD and REVERSE GEAR BACKLASH)

NOTE: Shimming can be accomplished by completing Method No. 1 or No. 2, following.

METHOD NO. 1 - SHIMMING

Forward Gear

a. Turn drive shaft clockwise several turns to align rollers in bearings. Fasten dial indicator to gear housing [Using holding tool (C-91-89897)] and Backlash Indicator Rod (C-91-53459) to drive shaft. (Figure 10)



a - Push
b - Indicator Rod
c - Dial Indicator
d - Holding Tool

Figure 10. Checking Gear Backlash

b. Shift gear housing into full forward. Turn drive shaft clockwise to ensure full engagement of sliding clutch.

c. Watch shift shaft movement. Slowly turn propeller shaft clockwise until shift shaft movement stops. Apply pressure on shift shaft toward forward gear. This will friction-lock sliding clutch and forward gear as one unit.

d. Position dial indicator pointer to line marked "I" on backlash indicator rod. Hold inward pressure on drive shaft. Lightly turn shaft and pinion gear assembly back-and-forth. DO NOT allow propeller shaft to turn. Dial indicator registers amount of backlash which must be .010" to .012" (0.25mm to 0.30mm) for pinion/forward gears with 20-33 teeth and .020" to .023" (0.50mm to 0.58mm) for pinion/forward gears with 17-28 teeth.

NOTE: Both forward and reverse gear backlash should be checked at one time so that changing of shims in either gear may be completed in one disassembly procedure.

e. If backlash is less than required, remove shims from forward gear bearing race. If backlash is more than required, add shims to forward gear bearing race.

NOTE: By adding or subtracting .001" (0.025mm) shim, the backlash will change approximately .0015" (0.038mm).

Reverse Gear

a. Turn drive shaft clockwise several turns to align rollers in bearings. Fasten dial indicator to gear housing and Backlash Indicator Rod (C-91-53459) to drive shaft. (Figure 10)

b. Shift gear housing into full reverse. Turn drive shaft clockwise to ensure full engagement of sliding clutch.

c. Watch shift shaft movement. Slowly turn propeller shaft counterclockwise until shift shaft movement stops. Apply pressure on shift shaft toward reverse gear. This will friction-lock sliding clutch and reverse gear as one unit.

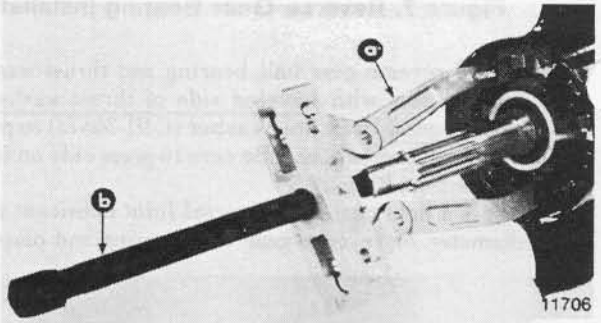
d. Position dial indicator pointer to line marked "I" on backlash indicator rod. Hold inward pressure on drive shaft. Lightly turn drive shaft and pinion gear assembly back-and-forth. DO NOT allow propeller shaft to turn. Dial indicator registers amount of backlash which must be .040" to .060" (1.02mm to 1.47mm). (Figure 10)

e. If backlash is less than required, add shims between reverse gear thrust washer and gear housing. If backlash is more than required, remove shims.

METHOD NO. 2 - SHIMMING

Forward Gear

a. Attach Bearing Carrier Removal Tool (C-91-46086A1) and Puller Bolt (C-91-85716) onto carrier and propeller shaft. (Figure 11)



a - Removal Tool
b - Puller Bolt

Figure 11. Preloading Forward Gear

b. Torque puller bolt against propeller shaft to 45 in. lbs. (52kg-cm). Turn drive shaft 2 or 3 revolutions with the load applied to propeller shaft. This will seat forward gear bearing.

c. Fasten dial indicator to gear housing [using holding tool (C-91-89897)] as shown in Figure 10.

d. Fasten Backlash Indicator Tool (C-91-53459) to drive shaft and position so that dial indicator touches the No. 1 mark and is perpendicular to Backlash Tool. (Figure 10)

e. Hold pressure down on drive shaft. Lightly turn drive shaft back-and-forth (no movement should be noticed at propeller shaft). Dial indicator registers amount of backlash, which must be .010" to .012" (0.25mm to 0.30mm) for pinion/forward gears with 20-33 teeth and .020" to .023" (0.50 mm to 0.58mm) for pinion/forward gears with 17-28 teeth. (Figure 10)

NOTE: Both forward and reverse gear backlash should be checked at one time so that changing of shim(s) in either gear may be completed in one disassembly procedure.

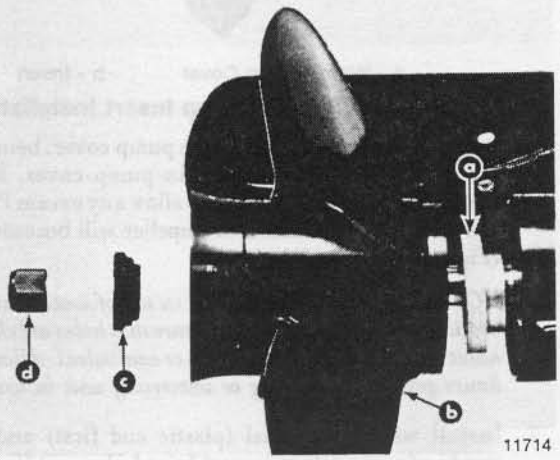
f. If backlash is less than required, remove appropriate shim thickness from forward gear bearing race. If backlash is more than required, add appropriate shim to forward gear bearing race.

NOTE: By adding or subtracting .001" (0.025mm) shim, the backlash will change approximately .0015" (0.038mm).

g. Reassemble per installation instructions and recheck backlash per instructions.

Reverse Gear

a. Place Collar C-91-30366 on propeller shaft with smaller diameter shoulder toward carrier. (Figure 12)
b. Install propeller and only splined washer. (Figure 12)
c. Screw propeller nut into place and tighten hand-tight [45 in. lbs. (52kg-cm)].



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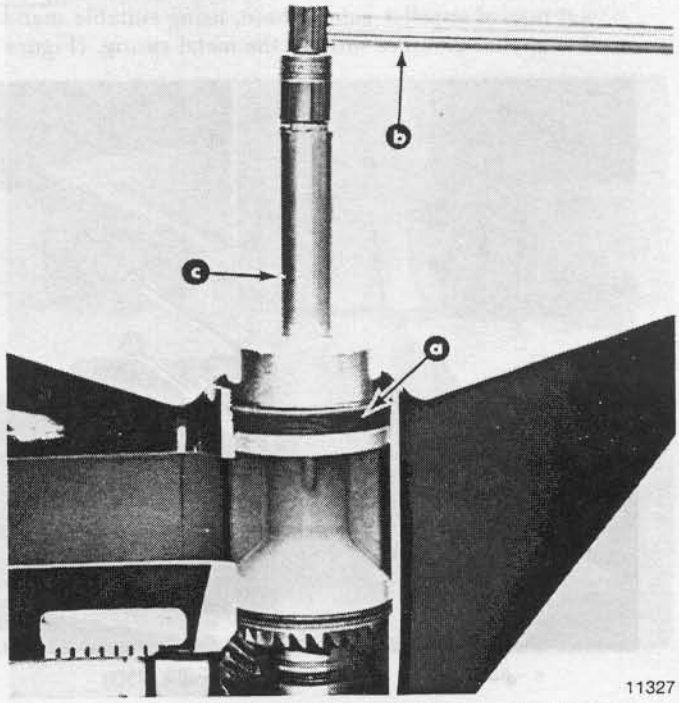
a - Collar (C-91-30366)
b - Propeller
c - Splined Washer
d - Propeller Nut

Figure 12. Preloading Reverse Gear

d. Turn drive shaft clockwise several turns to align rollers in bearings.
e. Fasten dial indicator to gear housing and Backlash Indicator Rod (C-91-53459) to drive shaft. (Figure 10) Be sure that dial indicator is touching the No. 1 mark and is perpendicular to Backlash Indicator Rod. (Figure 10)
f. Hold inward pressure on drive shaft. Lightly turn drive shaft and pinion gear assembly back-and-forth. DO NOT allow propeller shaft to turn. Dial indicator registers amount of backlash which must be .040" to .060" (1.02mm to 1.47mm). (Figure 10)
g. If backlash is less than required, add appropriate shim thickness from reverse gear thrust washer and gear housing. If backlash is more than required, remove appropriate shim thickness.
h. Reassemble per installation instructions and recheck backlash per instructions.
7. If forward and reverse backlash are correct, remove dial indicator and Backlash Tool, then remove collar, propeller, splined washer and propeller nut.
8. Install tab washer under retainer, if not already done, then torque retainer to specifications. (Figure 13) Bend one of the tabs on locking tab washer into one of the slots provided on bearing carrier retainer. (Figure 14)



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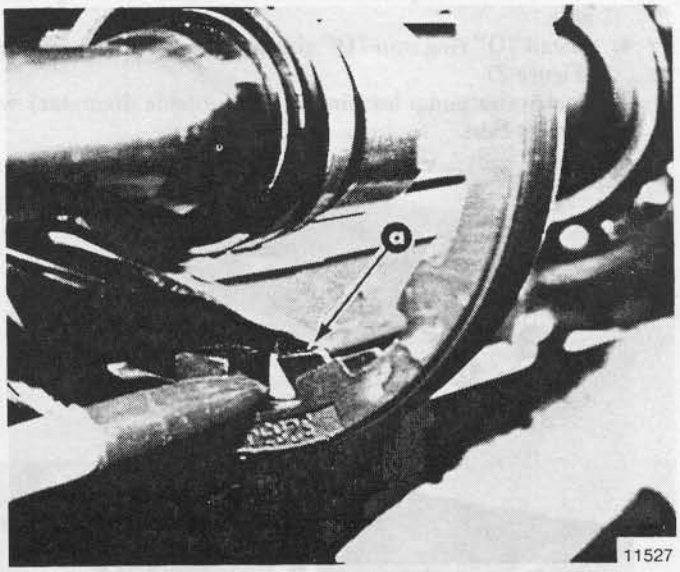
a - Retainer Nut
b - Torque Wrench (C-91-52523)
c - Cover Nut Tool

Figure 13. Bearing Carrier Installation



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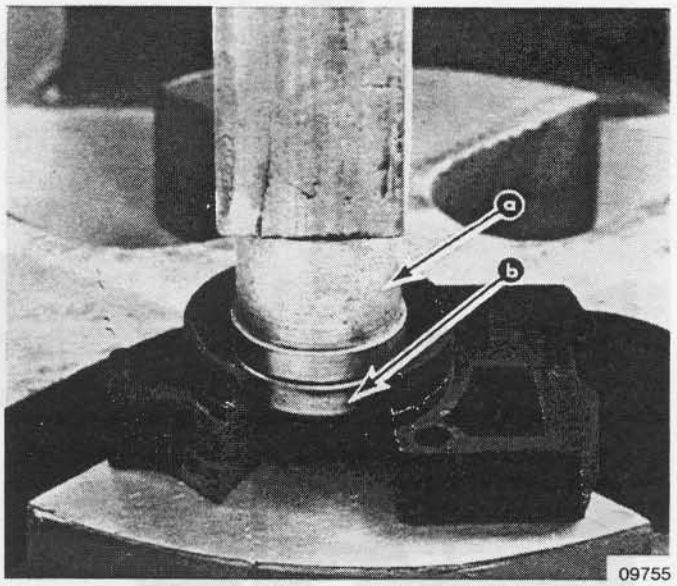
a - Bend Tab

Figure 14. Bending Tab Washer

Water Pump

REASSEMBLY

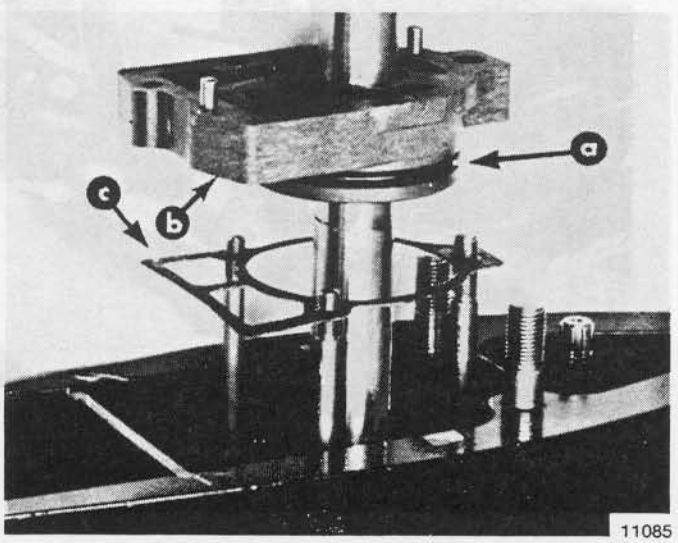
1. Just before installing each seal, apply Loctite Type "A" to outside diameter of oil seal.
2. Install small oil seal into water pump base with lip of oil seal toward impeller side of base, using suitable mandrel that applies pressure only to the metal casing. (Figure 1)



a - Mandrel b - Oil Seal (Smaller OD)

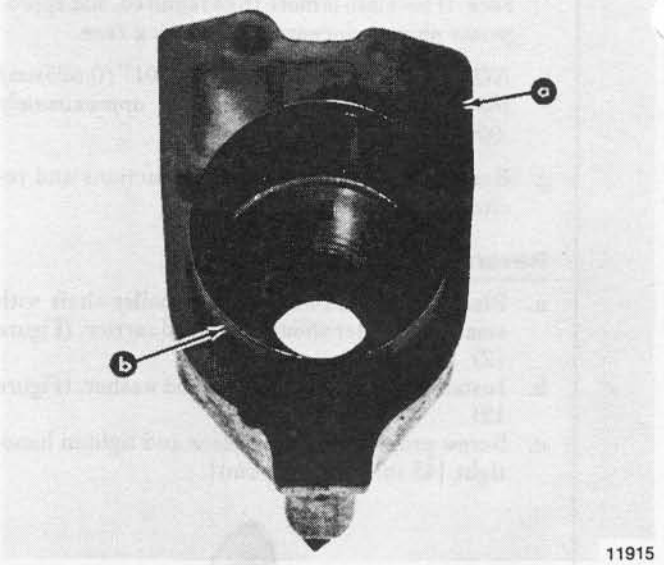
Figure 1. Installing Smaller OD Oil Seal in Water Pump Base

3. Install larger oil seal into pump base (using suitable mandrel) with lip of oil seal toward gear housing side of base.
4. Install "O" ring into "O" ring groove of water pump base. (Figure 2)
5. Coat water pump housing insert (outside diameter) with Perfect Seal.



a - "O" Ring b - Water Pump Base c - Gasket

Figure 2. Water Pump Base and Gasket



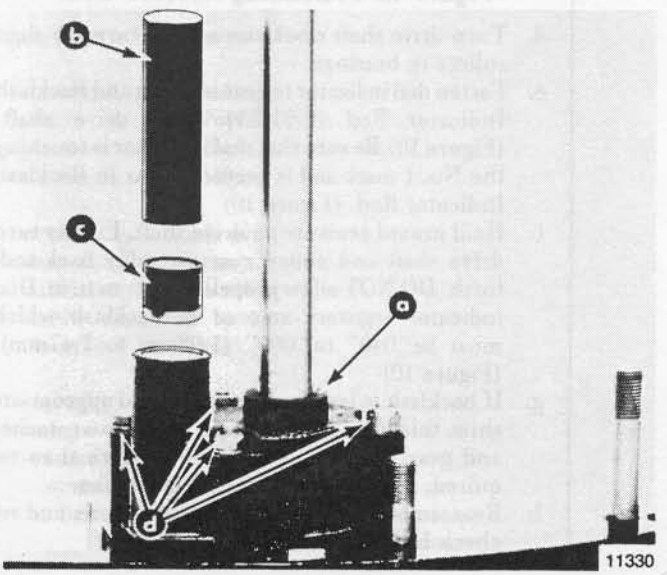
a - Water Pump Cover b - Insert

Figure 3. Water Pump Insert Installation

6. Install water pump insert into pump cover, being sure that tab on insert enters recess in pump cover. Remove all excess Perfect Seal. DO NOT allow any excess Perfect Seal to remain inside insert, or impeller will become damaged. (Figure 3)

   NOTE: If 2 holes were drilled in top of water pump cover to aid in removal of insert, make sure that holes are clean and fill holes with G.E. Silicone Sealer or equivalent. Allow to cure 24 hours prior to operating or immersing unit in water.

7. Install water tube seal (plastic end first) and lubricate inside of seal with universal Joint Lubricant [from U-Joint Grease Kit (c-91-74057A1)], then insert water inlet tube guide. (Figure 4)

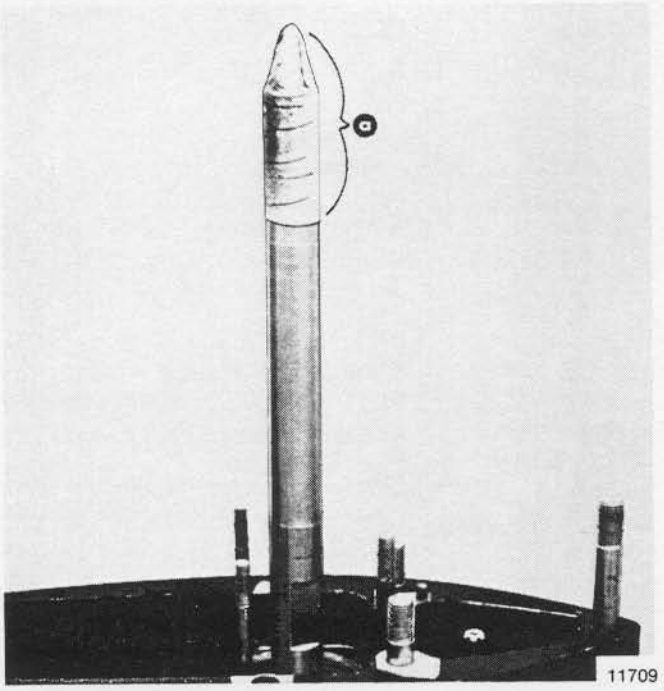


a - Centrifugal Slinger c - Water Tube Seal
b - Water Tube Guide d - Nuts, Bolt and Washer

Figure 4. Water Tube Seal Installation

INSTALLATION

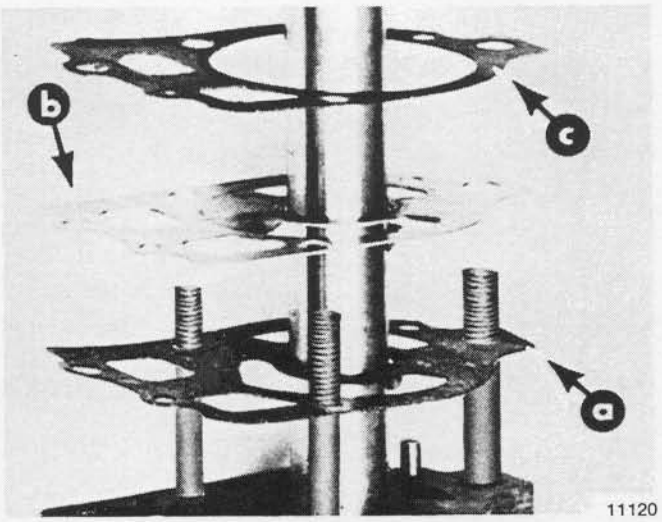
1. Lubricate pump base "O" ring and oil seal lips with Universal Joint Lubricant.
2. Wrap tape around drive shaft "O" ring groove, as shown in Figure 5. This protects water pump base seals from damage during installation.



a - Tape

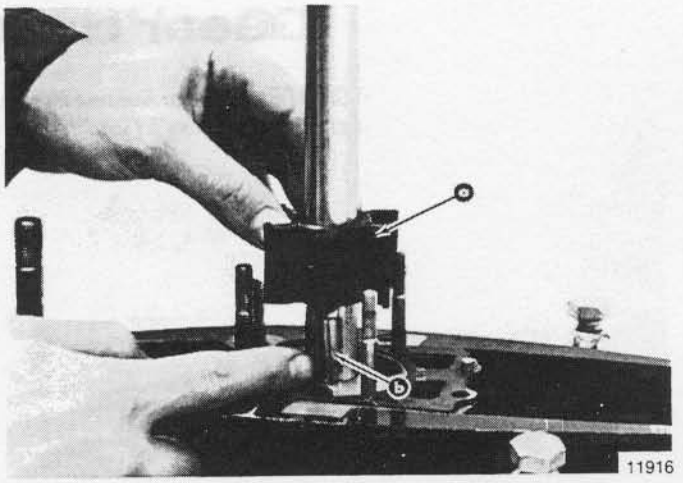
Figure 5. Taping Drive Shaft

3. Install a new pump base gasket over water pump mounting studs and slide water pump base over drive shaft and into gear housing.
4. Install lower gasket to water pump base, then face plate (lip down) and upper gasket. (Figure 6)
5. Remove tape used in Step 3.
6. Place impeller drive key on flat of drive shaft. Hold key on drive shaft with a dab of Universal Joint Lubricant. (Figure 7)



a - Gasket (Water Pump Base to Face Plate)
b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

Figure 6. Face Plate and Gasket Installation

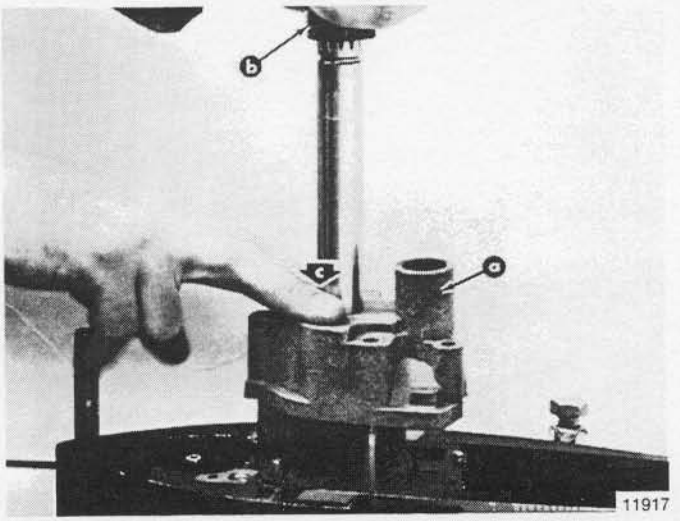


a - Impeller b - Key

Figure 7. Installing Impeller

IMPORTANT: When completing gear housing repair, that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary to re-use the impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur. Face the curl of the blades in counterclockwise direction (viewed from top).

7. Slide impeller over drive shaft, align impeller key slot with key and seat impeller on face plate.
8. Apply a soap and water solution on inside of water pump insert.
9. Position assembled water pump cover over drive shaft and lower over water pump studs. Rotate drive shaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover. (Figure 9)



a - Water Pump Cover b - Adaptor Nut c - Push

Figure 8. Installing Water Pump Cover

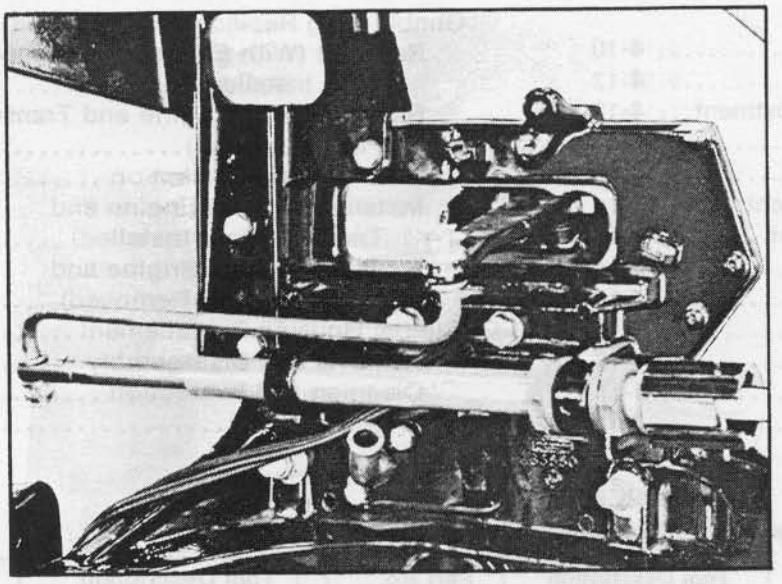
10. Install water pump cover retainer washers, nuts and bolt. (Figure 4)
11. Tighten bolt and nuts evenly to specified torque. DO NOT over-torque.
    NOTE: Always torque aft bolt and nuts prior to torquing forward nut.
12. Install centrifugal slinger and drive shaft "O" ring. (Figure 4)
13. Install "O" ring at top of drive shaft.

Gear Housing Installation

NOTE: For gear housing installation, refer to "Drive Shaft Housing to Gear Housing Installation" (see "Index" of "Drive Shaft Housing" section, preceding).

I-DRIVE

Transom Plate Assembly



SECTION 4

INDEX

	Page
Special Tools Required and Torques	Below
Transom Plate Assembly Removal	4-1
Transom Plate Installation	4-2
Installing Transom Plate	4-2
Hydraulic Trim Hose Connections	4-6
"In-Line" Engine	4-6
"V-8" Engine	4-6
Electrical Connections	4-7
"V-8" Engine	4-7
"In-Line" Engine	4-7
Attaching Stern Drive Unit Shift Cable	4-8
Attaching Remote Control Shift Cable	4-9
Attaching Power Steering Hydraulic Hoses	4-9
Transom Plate Adjustments	4-10
Shift Cables and Cutout Switch Adjustments	4-10
Reverse Lock Valve Adjustment	4-12
Power Steering Control Valve Adjustment	4-12
Trim Limit Switch Adjustment	4-13
Trim Position Sender Adjustment	4-13
Transom Plate Component Replacement	4-14
Drive Unit Shift Cable Replacement	4-14
Removal	4-14
Inspection	4-15
Installation	4-15
Gimbal Bearing Replacement	4-17
Inspection	4-17
Removal	4-17
Installation	4-17
Trim Limit Switch and Trim Position Sender Replacement	4-[illegible]
Testing Trim Limit Switch	4-18
Testing Power Trim Indicator Sender	4-18
Removal	4-18
Installation	4-18
Exhaust Elbow and Shutter Replacement	4-19
"In-Line" Engine Shutter Replacement	4-19
"V-8" Engine Shutter Replacement	4-19
Exhaust Elbow Removal	4-20
Exhaust Elbow Installation	4-20
Bell Housing and Bellows Replacement	4-21
Removal and Disassembly	4-21
Cleaning and Inspection	4-22
Installation	4-22
Gimbal Ring Replacement	4-25
Removal (With Engine and Transom Plate Installed)	4-25
Removal (With Engine and Transom Plate Removed)	4-29
Cleaning and Inspection	4-29
Installation (With Engine and Transom Plate Installed)	4-29
Installation (With Engine and Transom Plate Removed)	4-33
Gimbal Housing Replacement	4-34
Removal and Disassembly	4-[illegible]
Cleaning and Inspection	4-[illegible]
Installation	4-34

SPECIAL TOOLS

(Required for Transom Plate Assembly Service)

Tool Description	Part No.
Expander Tool	C-91-45497A1
Puller	C-91-63616
Puller Shaft	C-91-31229
Nut	C-11-24156
Slide Hammer Puller	C-91-34569A1
Plate (2)	C-91-29310

Tool Description	Part No.
Washer	C-12-34961
Driver Rod	C-91-37323
Driver Head	C-91-32325
Tap & Hole Saw Kit	C-91-86191A1
Engine Alignment Shaft	C-91-57797A3

Tool Description	Part No.
Mandrel	C-91-30366
Hinge Pin Tool	C-91-78310
Puller Head	C-91-38919
Driver	C-91-33492
Driver	C-91-33491
Driver	C-91-33489

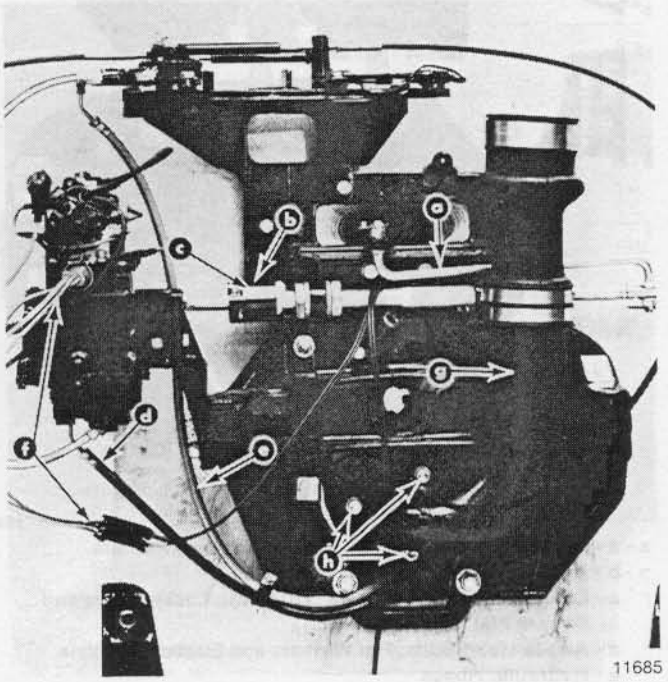
TORQUE SPECIFICATIONS

(For "Reassembly" in This Section)

Description	Thread	Torque
Gimbal Housing to Inner Transom Plate Nuts & Bolts	1/2-13 7/16-20 7/16-14	20-25 Ft. Lbs. (2.77-3.46mkg)
Exhaust Elbow or Separator to Gimbal Housing Cap Screws	3/8-16	20-25 Ft. Lbs. (2.77-3.46mkg)
Exhaust Elbow to Separator Cap Screws	3/8-16	20-25 Ft. Lbs. (2.77-3.46mkg)
Pivot Bolt to Steering Lever Lock Nut	3/8-24	15-18 Ft. Lbs. (2.07-2.49mkg)
Steering Link Rod Nut(s)	3/8-24	20-25 In. Lbs. (23-29kg-cm)
Bellows Clamps	———	35-38 In. Lbs. (40-44kg-cm)
Swivel Shaft Pipe Plug	———	45-50 Ft. Lbs. (6.22-6.92mkg)
Steering Arm Cross Bolt Nut	7/16-20	55-60 Ft. Lbs. (7.61-8.30mkg)
Hinge Pin	5/8-18	60 Ft. Lbs. (8.30mkg)
Gimbal Ring Screws	3/8-24	25 Ft. Lbs. (3.46mkg)

TRANSOM PLATE ASSEMBLY REMOVAL

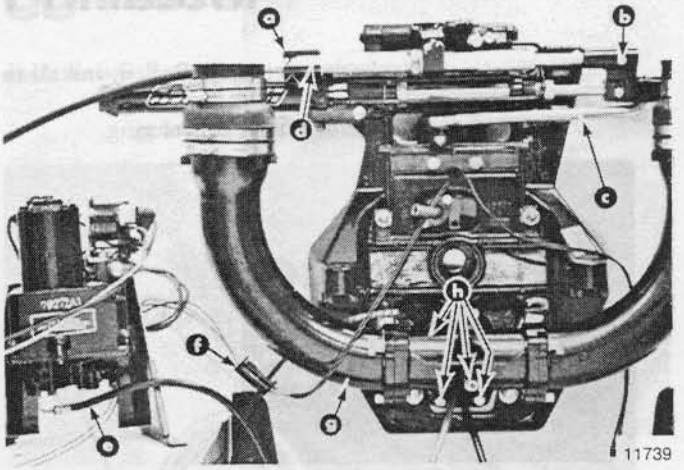
1. Remove drive unit as explained in "Drive Shaft Housing Removal - Separating Drive Shaft Housing from Gimbal Housing" (see "Index").
2. Remove engine as explained in Engine Service Manual (see "Index" in manual).



a - Steering Link Rod
b - Locking Sleeve
c - Steering Cable Coupler Nut
d - Black Hydraulic Hose
e - Gray Hydraulic Hose
f - Trim Wire Harness
g - Exhaust Elbow
h - Allen Head Screws

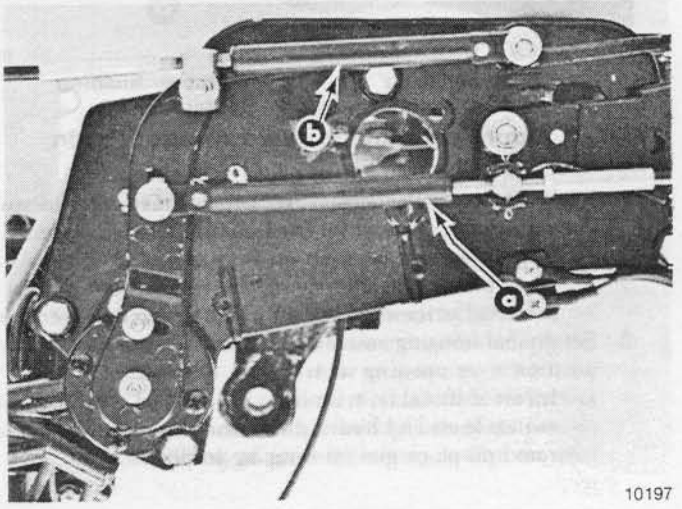
Figure 1. Removing "In-Line" Transom Plate

3. Remove steering link rod. (Figure 1 or 2)
4. Disconnect and remove steering cable from tube, as follows:
   a. Remove cotter pin from locking sleeve, then remove sleeve. (Figure 1 or 2)
   b. On "V-8" installations, remove clevis pin from cable end adaptor. (Figure 2)
   c. Remove steering cable coupler nut and slide steering cable from support tube. (Figure 1 or 2)
5. Remove black hydraulic hose from base of trim pump and, on "In-Line" installations, remove gray hose from reverse lock valve. Cap hoses and plug hose connections.
6. Remove exhaust elbow or elbow assembly from gimbal housing. (Figure 1 or 2)
7. Disconnect trim limit switch leads from trim wiring harness. (Figure 1 or 2)
8. Remove Power Steering lines from control valve (if equipped).



a - Locking Sleeve
b - Clevis Pin
c - Steering Link Rod
d - Steering Cable Coupler Nut
e - Black Hydraulic Hose
f - Trim Wire Harness
g - Exhaust Assembly
h - Cap Screws

Figure 2. Removing "V-8" Transom Plate



a - Drive Unit Shift Cable
b - Remote Control Shift Cable

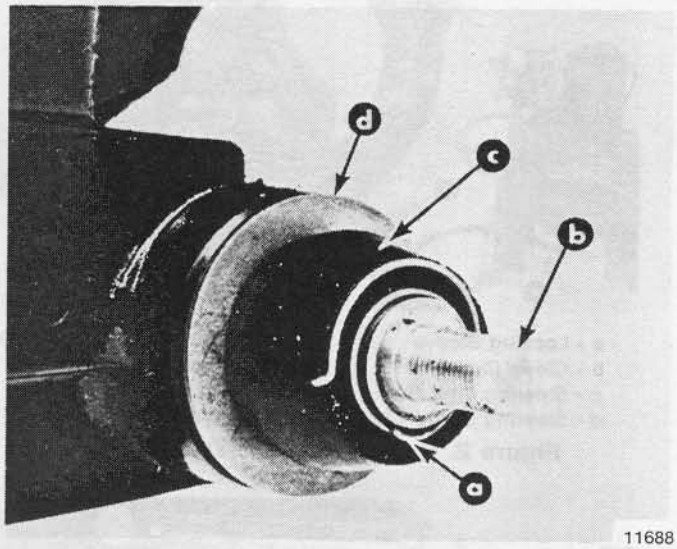
Figure 3. Removing "In-Line" Shift Cables

9. On "In-Line" engine installations, disconnect Power Trim panel wiring harness from pump, if pump is mounted to transom plate assembly. (Figure 1) It will be necessary to remove both remote and drive unit shift cables. (Figure 3)
10. Remove screws and nuts, which hold inner and outer transom plates together, then remove inner transom plate and outer transom plate in that order.

TRANSOM PLATE INSTALLATION

Installing Transom Plate

1. If hydraulic trim cylinders are not installed, install them as follows:
   a. Insert forward anchor pin in gimbal ring.



11688

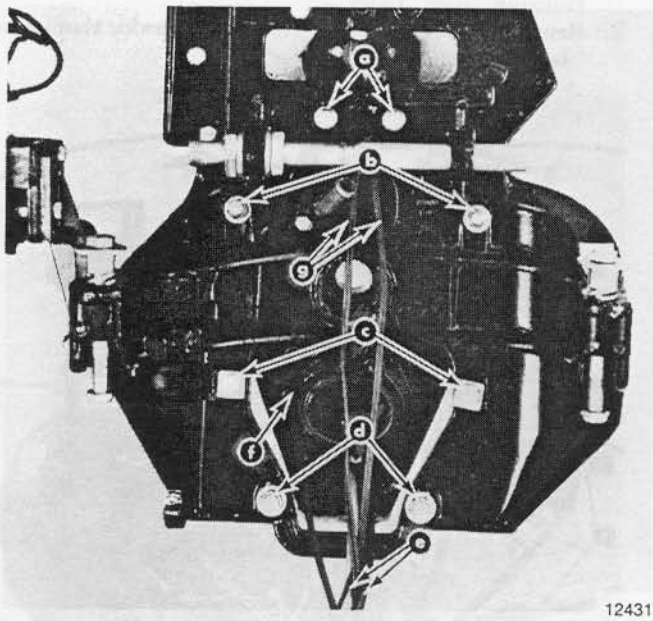
a - Spiral Spring
b - Forward Anchor Pin
c - Rubber Bushing
d - Flat Washer

Figure 4. Installing Forward Anchor Pin

   b. Place one each flat washer, rubber bushing and spiral spring on each side of forward anchor pin. (Figure 4)
   c. Place cylinders in position on forward anchor pin.
   d. Place one each rubber bushing, flat washer and nut on each end of forward anchor pin. Tighten nuts securely.
2. Set gimbal housing assembly and inner transom plate into position over opening in transom, as follows:
   a. Insert shift cable, trim limit switch and trim indicator switch leads and hydraulic hoses thru opening in transom and place gimbal housing in position.

CAUTION: DO NOT hold gimbal housing in position by the trim limit and trim indicator leads while fastening inner transom plate. Switch leads or switches could be damaged.

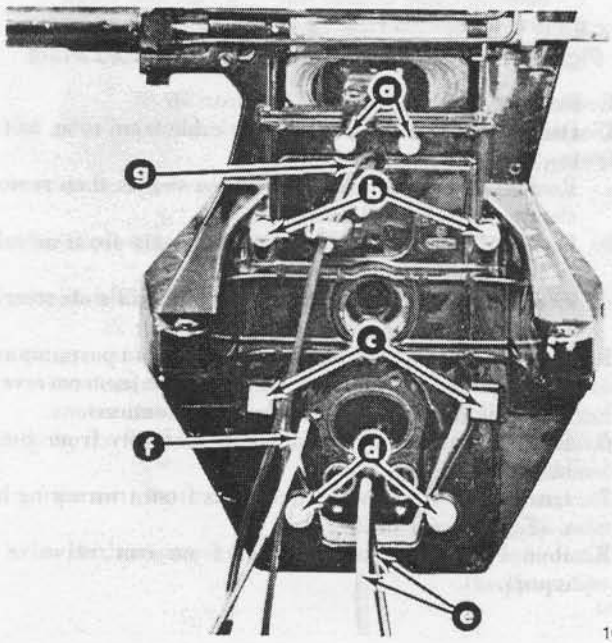
   b. While holding gimbal housing in this position, insert shift cable and hydraulic hose thru large opening on inner transom plate. Insert trim limit switch and trim indicator switch leads thru center hole of 3 small holes in inner transom plate and set plate in position. (Figure 5 or 6)
3. Fasten gimbal housing assembly and inner transom plate to transom, as follows:
   a. Thread 2 short cap screws with lockwashers thru top 2 holes of inner transom plate into gimbal housing. (Figure 5 or 6)
   b. Insert 2 special anode head bolt assemblies (with rubber seals placed between bolts and gimbal housing) thru bottom 2 holes of gimbal housing, transom and inner transom plate.



12431

a - Shorter Cap Screws [2" (51mm)] and Lockwashers
b - Elastic Stop Nuts and Flat Washers
c - Longer Cap Screws [4-1/4" (10.8cm)], Lockwashers and Square Flat Washers
d - Anode Head Bolts, Flat Washers and Elastic Stop Nuts
e - Hydraulic Hoses
f - Shift Cable
g - Trim Limit Switch and Trim Indicator Leads

Figure 5. Installing "In-Line" Transom Assembly



10259

a - Shorter Cap Screws [2" (51mm)] and Lockwashers
b - Elastic Stop Nuts and Flat Washers
c - Longer Cap Screws [4-1/4" (10.8cm)], Lockwashers and Square Flat Washers
d - Anode Head Bolts, Flat Washers and Elastic Stop Nuts
e - Hydraulic Hoses
f - Shift Cable
g - Trim Limit Switch and Trim Indicator Leads

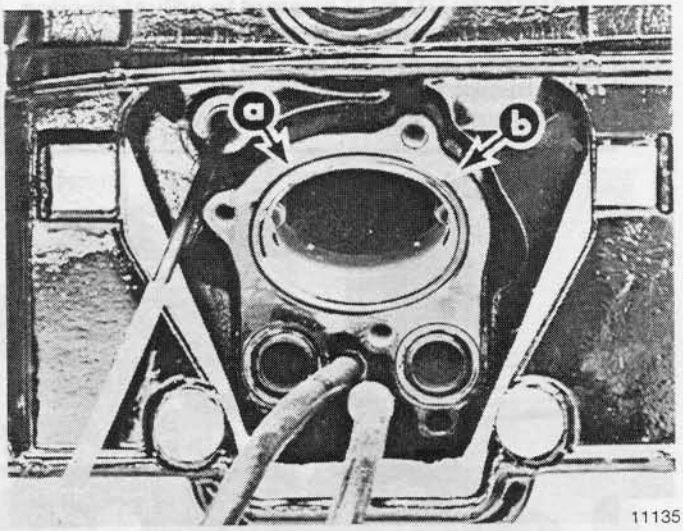
Figure 6. Installing "V-8" Transom Assembly

c. Place flat washers on bolts and thread on 2 elastic stop nuts.
d. Place flat washers on 2 studs, which protrude thru inner transom plate, and thread on 2 elastic stop nuts.

CAUTION: DO NOT attempt to drive cap screws thru transom, as threads in gimbal housing will be damaged.

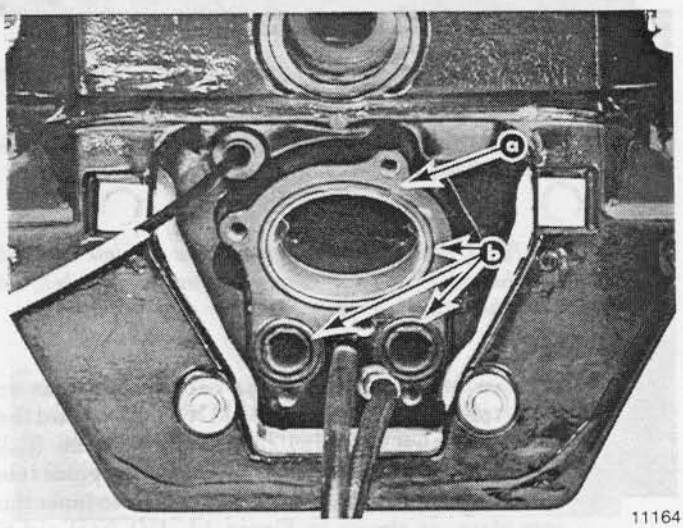
e. Thread 2 long cap screws with square flat washers and lockwashers thru remaining holes in inner transom plate into gimbal housing. Square washers should be against transom plate.

5. Tighten transom plate cap screws and elastic stop nuts EVENLY, then torque to 20-25 ft. lbs. (2.7mkg-3.4mkg).



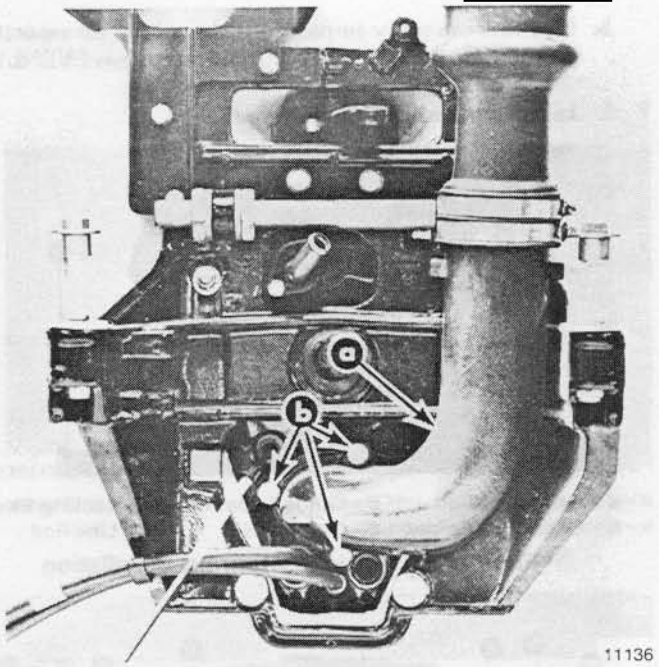
a - Mating Surface b - "O" Ring Seated in Groove

Figure 7. "In-Line" Exhaust Elbow "O" Ring Location



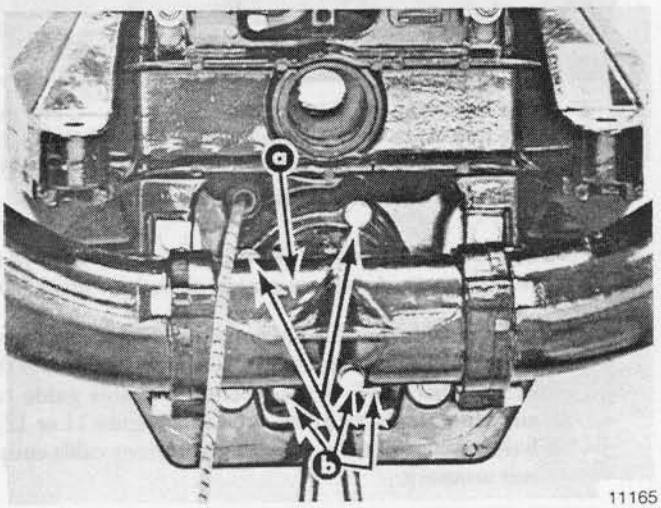
a - Mating Surface b - "O" Rings Seated in Grooves

Figure 8. "V-8" Exhaust Elbow Assembly "O" Ring Location



a - Exhaust Elbow b - Socket or Hex Head Cap Screws and Lockwashers

Figure 9. Installing Exhaust Elbow ("In-Line")



a - Exhaust Assembly b - Retaining Cap Screws and Lockwashers

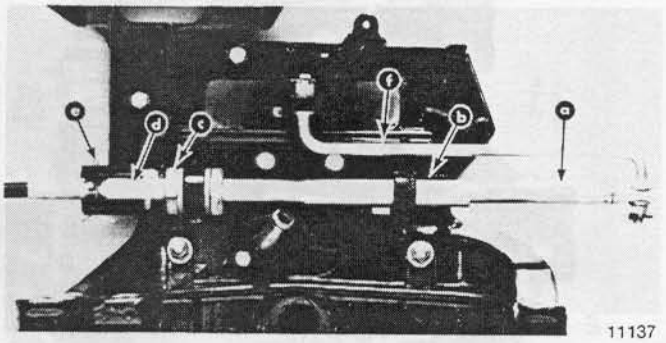
Figure 10. Installing Exhaust Assembly ("V-8")

6. Install exhaust elbow or elbow assembly to gimbal housing, as follows:
   a. Be certain that mating surfaces of exhaust elbow (or separator) and gimbal housing are clean and that "O" ring(s) are properly seated in groove(s). (Figure 7 or 8)

CAUTION: Be sure that "O" ring(s) remain seated in groove(s) of gimbal housing to properly seal joint, or leakage will occur.

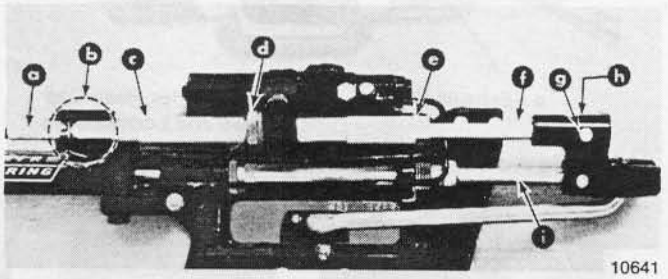
b. Place cap screw in positions thru elbow for separator, as shown in Figure 9 or 10. Torque screws EVENLY to 20-25 ft. lbs.

7. Install steering cable as follows:



a - Cable End Rod
b - Cable End Guide
c - Guide Tube Nut
d - Coupler Nut
e - Locking Sleeve
f - Link Rod

Figure 11. "In-Line" Steering Installation



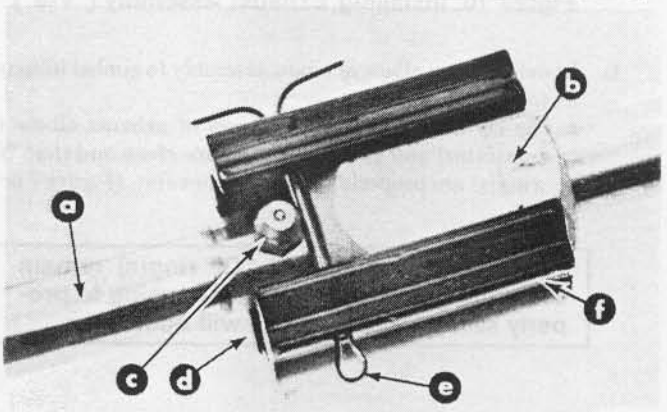
a - Cable End Rod
b - Cable End Guide
c - Adjusting Sleeve
d - Coupler Nut
e - Locking Sleeve
f - Adaptor
g - Clevis Pin
h - Link Rod
i - Guide Slide

Figure 12. "V-8" Steering Installation

NOTE: On "V-8" engine installations, place clear plastic guide slide on guide tube to protect threads. (Figure 12)

a. Lubricate inside of cable guide tube and cable end rod with Special Lubricant No. 101 and insert cable thru cable guide tube. Place wrench on cable guide tube adjusting sleeve or guide tube nut (Figure 11 or 12) to hold tube from turning while tightening cable coupler nut securely.

CAUTION: Failure to use specified grease (No. 101) can result in damage to associated parts.



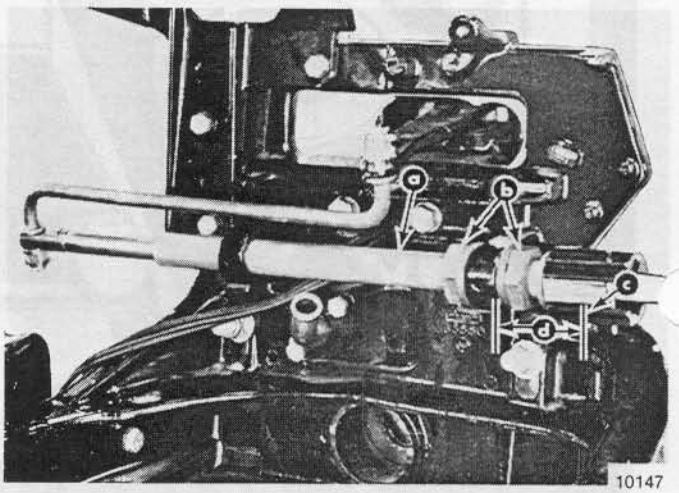
a - Steering Cable
b - Coupler Nut
c - Grease Fitting
d - Rubber Bumper
e - Cotter Pin
f - Locking Sleeve

Figure 13. Locking Sleeve Installed on Coupler Nut

b. Install locking sleeve on coupler nut (Figure 15), as follows:
   1) Position rubber bumper into locking sleeve, inserting bumper between locating pin into hole provided (if not already installed).
   2) Position locking sleeve over steering cable at cable coupler nut end. Slide locking sleeve over coupler nut, as shown in Figure 13. Secure locking sleeve with cotter pin. Pin must be located between grease fitting and cable coupler nut. Spread ends of cotter pin.

c. On "V-8" installations, connect cable output shaft to adaptor with clevis pin thru adaptor so that cotter pin is between adaptor and transom. (Figure 12)

CAUTION: DO NOT attempt to adjust steering cable guide tube, as guide tube adjusting nut and sleeve have been torqued with Loctite, and an attempt to loosen adjusting nut or sleeve may result in damage to tube.



a - Guide Tube
b - Guide Tube Nuts
c - Line Represents End of Guide Tube
d - This Dimension 1-5/8" (41.3mm)

Figure 14. Attaching Steering Cable from Left Side ("In-Line")

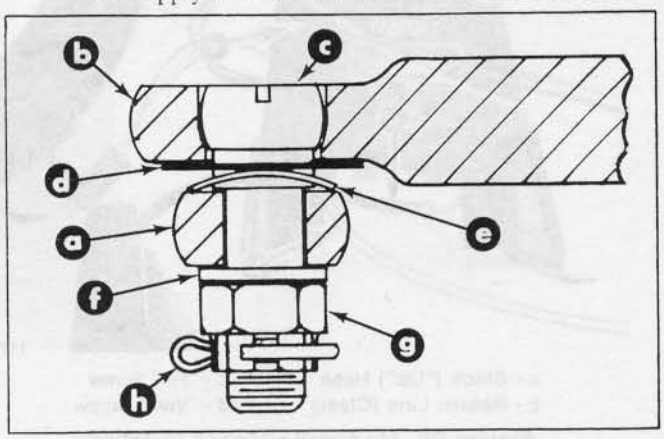
NOTE: If installing new guide tube for left side cable attachment ("In-Line" engine installation only), complete the following. (Figure 14)

Remove and discard steering cable guide tube and guide tube jam nuts. (Figure 14) DO NOT discard the 2 guide tube washers. Install new guide tube (C-32-35015), washers (removed from discarded guide tube) and new guide tube nuts (C-11-37984) onto inner transom plate, as shown in Figure 14. DO NOT tighten nuts. Adjust guide tube nuts to achieve 1⅝" (41.3mm) measured from threaded end of guide tube to guide tube mounting embossment. Back off both nuts and apply Locquic Primer (C-92-59327), then Loctite No. 35 (C-92-59328) to guide tube threads in area where guide tube nuts will be located. Recheck 1⅝" dimension and tighten nuts securely.

8. Install steering link rod. (Figure 11, item "f", or Figure 12, item "h")

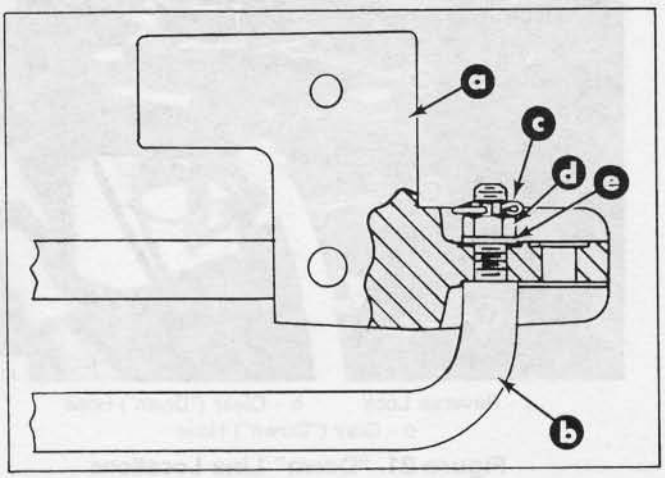
a. On "V-8" engine installations, connect steering link rod to steering lever with pivot bolt thru rod and nylon washer and wave washer between rod and lever. (Figure 15) Align wave washer with shoulder on pivot bolt and secure with flat washer and castle nut. Torque castle nut to 15-18 ft. lbs. (2.07-2.49mkg) maximum and install cotter pin. If hole in link rod does not align with nearest notch in castle nut, back nut off slightly until it does, then install cotter pin. Spread ends of cotter pin. Attach steering link rod to cable end adaptor with flat washer and castle nut. (Figure 16) Torque to 20-25 in. lbs. (23-28kg-cm) maximum, then back off to nearest cotter pin hole. Install cotter pin and spread ends of cotter pin.

b. On "In-Line" engine installations, attach steering link rod thru hole (located in end of steering lever) on drive unit. Apply Universal Joint Lubricant to hole in steering lever and to special sleeve. (Figure 17) Secure rod to lever with special sleeve, thin washer and castle nut. Torque nut to no more than 20-25 in. lbs. (23-29 kg/cm) and, if necessary, back nut off slightly to install cotter pin. Apply Universal Joint Lubricant to hole in cable output shaft and to steering link rod end. Attach steering link rod to cable output shaft, using thick washer, as shown in Figure 18. Torque castle nut to 20-25 in. lbs. (23-29kg/cm) and, if necessary, back off nut slightly to install cotter pin.



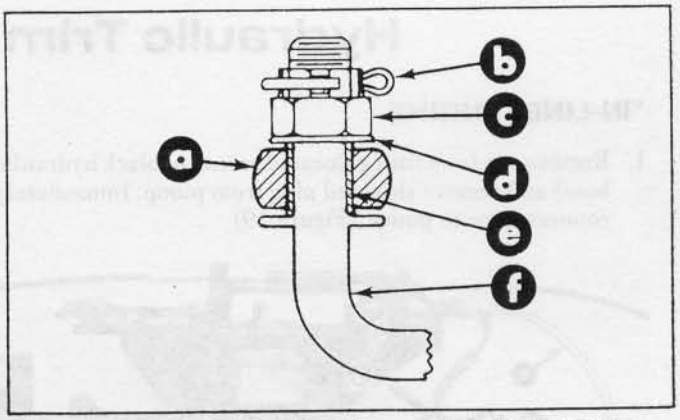
a - Steering Arm
b - Steering Link Rod
c - Pivot Bolt
d - Nylon Washer
e - Curved Washer
f - Flat Washer
g - Castle Nut [Torque to 15-18 Ft. Lbs. (2.1-2.5mkg)]
h - Cotter Pin

Figure 15. Connecting Steering Link Rod to Steering Lever



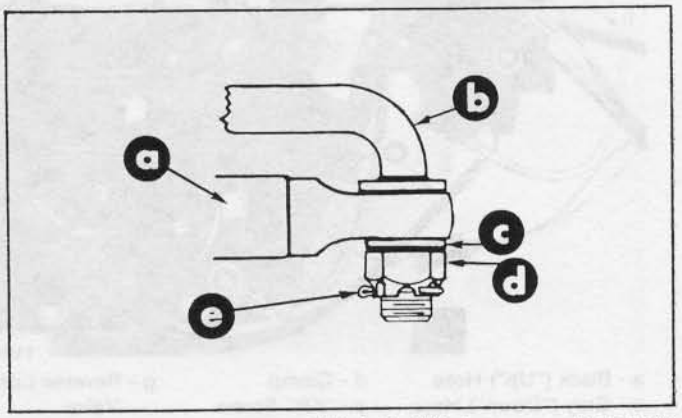
a - Cable End Adaptor
b - Steering Link Rod
c - Cotter Pin
d - Castle Nut
e - Flat Washer

Figure 16. Connecting Steering Link Rod to End Adaptor



a - Steering Lever
b - Cotter Pin
c - Castle Nut
d - Thin Flat Washer
e - Plastic Sleeve
f - Steering Link Rod

Figure 17. Steering Link Rod Attached to Steering Lever



a - Steering Cable End
b - Steering Link Rod
c - Thick Flat Washer
d - Castle Nut
e - Cotter Pin

Figure 18. Steering Link Rod Attached to Steering Cable

9. Install engine as explained in Engine Service Manual (see "Index" in manual).

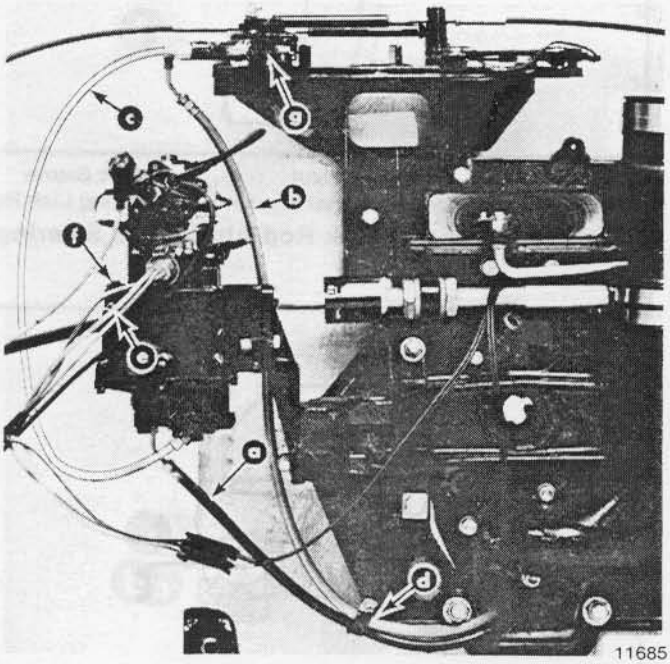
CAUTION: Before installing stern drive unit, check engine alignment with Engine Coupler Alignment Shaft (C-91-48247 or C-91-57797A3). (Refer to "Drive Shaft Housing to Gimbal Housing Installation".)

10. Install drive unit as explained in "Drive Shaft Housing to Gimbal Housing Installation" (see "Index").

Hydraulic Trim Hose Connections

"IN-LINE" ENGINE

1. Remove cap from fitting (located on end of black hydraulic hose) and remove threaded plug from pump. Immediately connect hose to pump. (Figure 19)



a - Black ("Up") Hose
b - Gray ("Down") Hose
c - Return Line
d - Clamp
e - "Fill" Screw
f - "Vent" Screw
g - Reverse Lock Valve

Figure 19. Hydraulic Hoses Installed

2. Remove cap from fitting (located on end of gray reverse lock valve hydraulic hose) and remove threaded plug from reverse lock valve. (Figure 19) DO NOT allow oil to run out of hose or valve. Immediately connect hose to valve. Tighten fittings securely.
3. Clamp hydraulic hoses securely to transom plate at location shown in Figure 19. Use clamp and screw (located on transom plate).

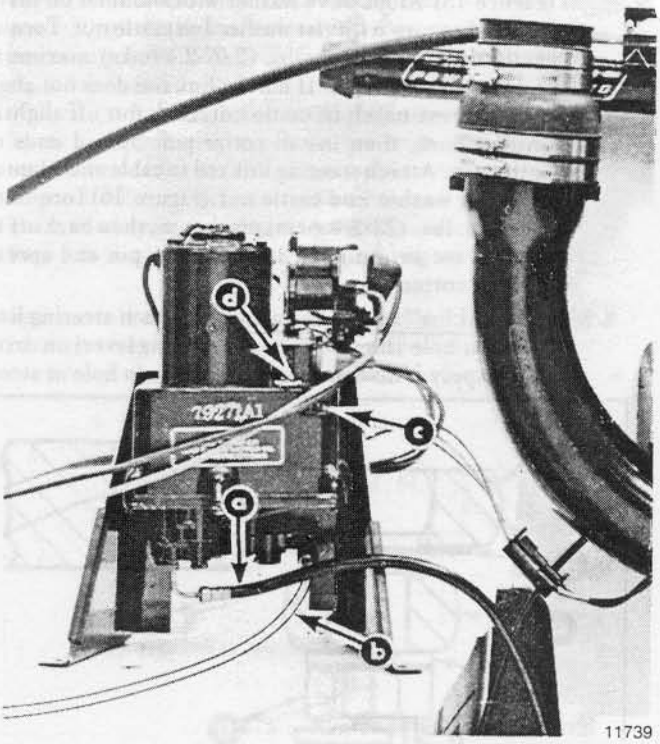
IMPORTANT: Failure to comply with preceding Steps 1, 2, and 3 may cause hydraulic hose to become damaged and render hydraulic system inoperative.

4. Loosen pump reservoir "Vent" screw approximately 2 turns. (Figure 19) Note that vent MUST BE open for proper operation.
5. With drive unit down all-the-way in normal operating position, check trim pump oil level by removing "Fill" screw. If necessary, fill to bottom of threads with a SAE 10W-30 or SAE 10W-40 motor oil. DO NOT over-fill.
6. Replace "Fill" screw.

"V-8" ENGINE

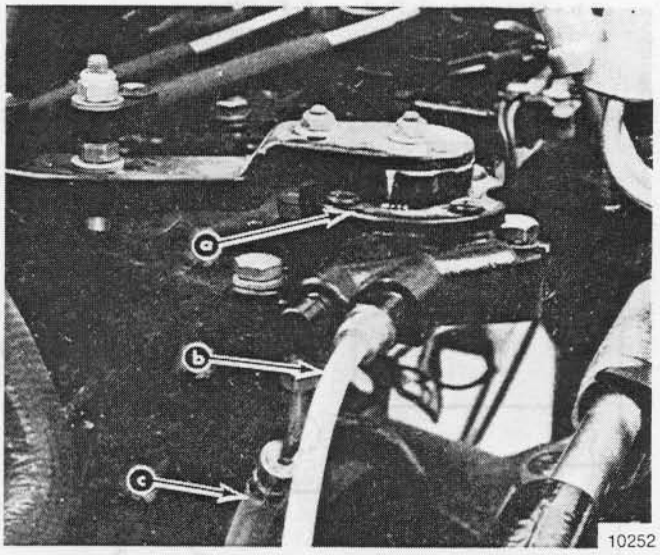
1. Route black hydraulic hose toward trim pump.

NOTE: If hydraulic pump is mounted on port side of engine, route "up" hydraulic hose (black) toward the hydraulic pump. DO NOT allow oil to drain thru fittings during connection. Tighten all fittings securely.



a - Black ("Up") Hose
b - Return Line (Clear)
c - "Fill" Screw
d - "Vent" Screw

Figure 20. Hydraulic Hoses Installed



a - Reverse Lock
b - Clear ("Down") Hose
c - Gray ("Down") Hose

Figure 21. "Down" Line Locations

2. Remove cap (installed in disassembly) from hydraulic fitting (located on end of black, gimbal housing hydraulic hose), remove threaded plug (installed in disassembly) from pump control valve and immediately connect hose to control valve. (Figure 20)

3. Connect clear "down" hydraulic hose from pump control valve to reverse lock valve after removing plug (installed in disassembly) from reverse lock valve and cap from hose. (Figure 21)
4. Connect gray "down" hydraulic hose from gimbal housing to reverse lock valve after removing cap from hose fitting and plug from valve. (Figure 21)

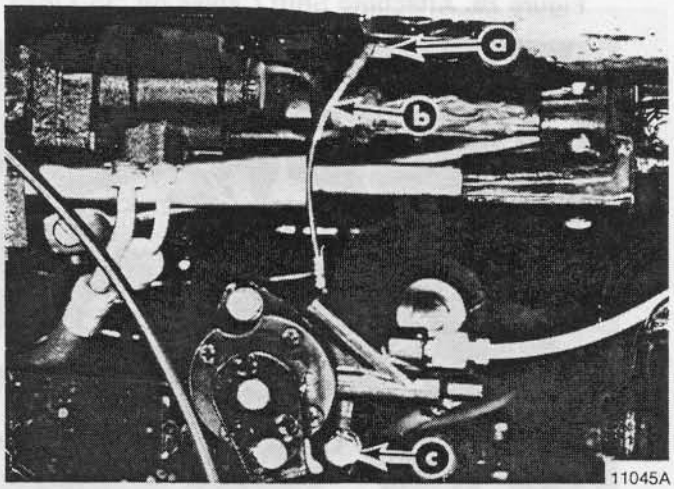
IMPORTANT: Failure to comply with preceding Steps 1, 2, 3 and 4 may cause hydraulic hose to become damaged and render hydraulic system inoperative.

5. Loosen pump reservoir "Vent" screw 2 full turns. (Figure 20) Note that vent must be open for proper operation.
6. With drive unit down all-the-way in normal operating position, check trim pump oil level by removing "Fill" screw. (Figure 20) If necessary, fill to bottom of threads with SAE 10W-30 or SAE 10W-40 automotive oil. DO NOT overfill.
7. Replace "Fill" screw.

Electrical Connections

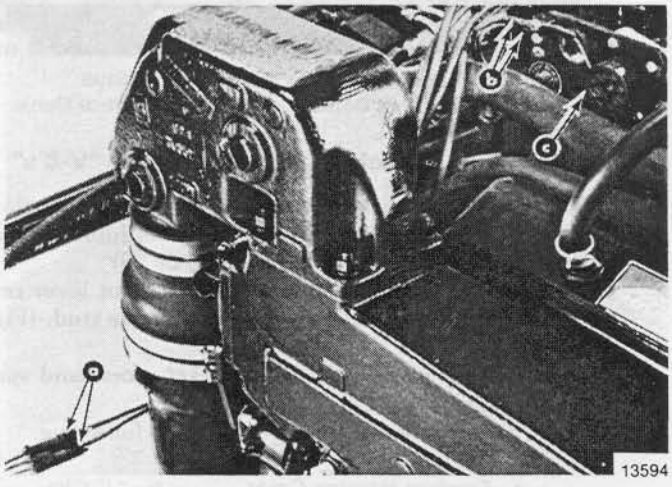
"V-8" ENGINE

1. Connect ground wire between reverse lock valve and screw on port side of transom plate. (Figure 22)
2. Connect trim limit switch leads to trim control harness. (Figure 23)
3. Connect trim sender leads to terminal block on engine bracket next to instrument harness plug-in. (Figure 23) (Purple sleeved wire is connected to brown/white wire.)



a - Screw in Transom
b - Ground Wire
c - Reverse Lock Valve Mounting Screw

Figure 22. Ground Wire Location

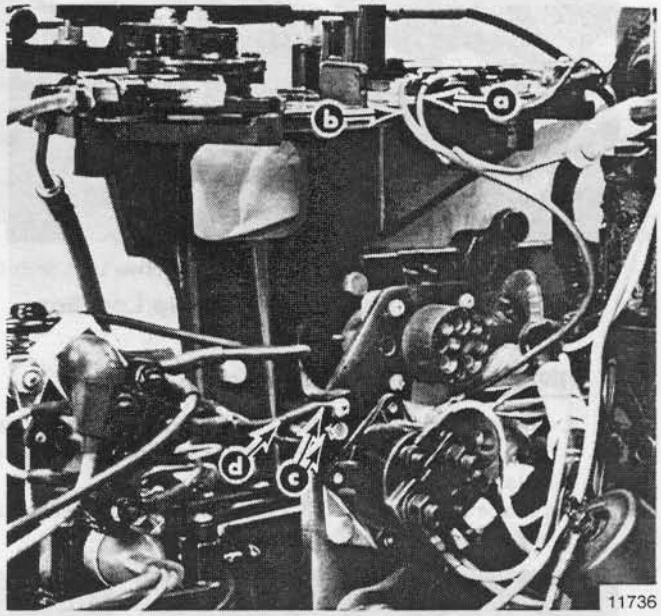


a - Trim Limit Switch Leads
b - Trim Sender Leads
c - Plug-In Harness Bracket

Figure 23. Connecting Trim Limit and Trim Sender Leads

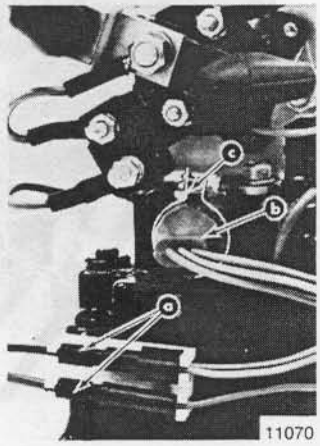
"IN-LINE" ENGINE

1. Connect shift cutout switch leads to terminal block on shift plate. (Figure 24)
2. Connect Power Trim panel wiring harness to hydraulic pump and secure connection with clamp. (Figure 25)
3. Connect trim limit switch leads to Power Trim panel wiring harness. (Figure 25)
4. Connect trim sender leads to terminal block on engine bracket next to instrument harness plug-in. (Figure 24)



a - Gray Wire from Engine
b - Black Wire from Harness Bracket
c - Trim Sender Leads
d - Purple Sleeve

Figure 24. Cutout Switch and Trim Sender Connected



a - Trim Limit Switch Connections
b - Hydraulic Pump Connection
c - Clamp

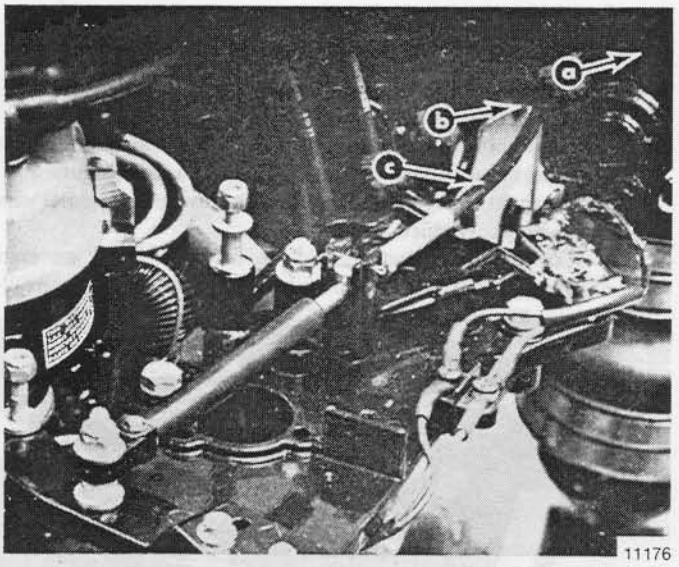
Figure 25. Power Trim Wiring Harness Connected

Attaching Stern Drive Unit Shift Cable

1. Route stern drive shift cable as follows:

"V-8" Engine Installations

a. Route drive unit shift cable over the top of exhaust separator, then between exhaust separator toward right (starboard) side of engine.
b. Route cable back toward engine under right (starboard) exhaust elbow thru "J" clip. (Figure 26) (DO NOT bend "J" clip shut until remote control shift cable is installed.)

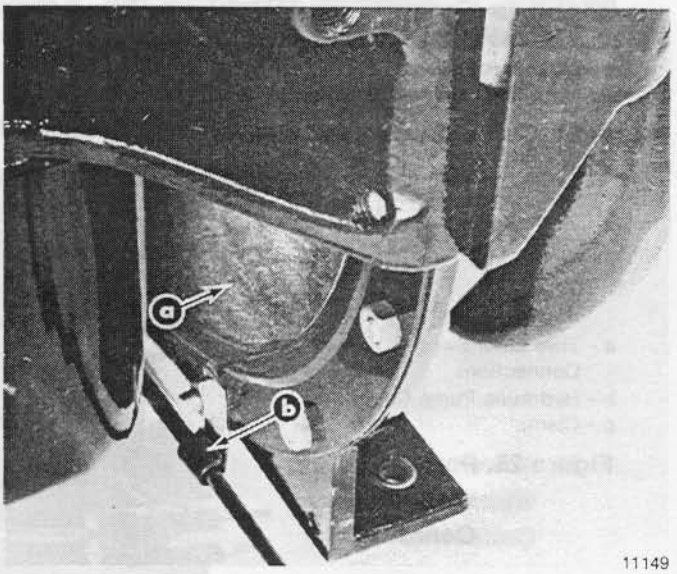


a - Exhaust Elbow b - "J" Clip c - Drive Unit Shift Cable

Figure 26. Shift Cable "J" Clip Location

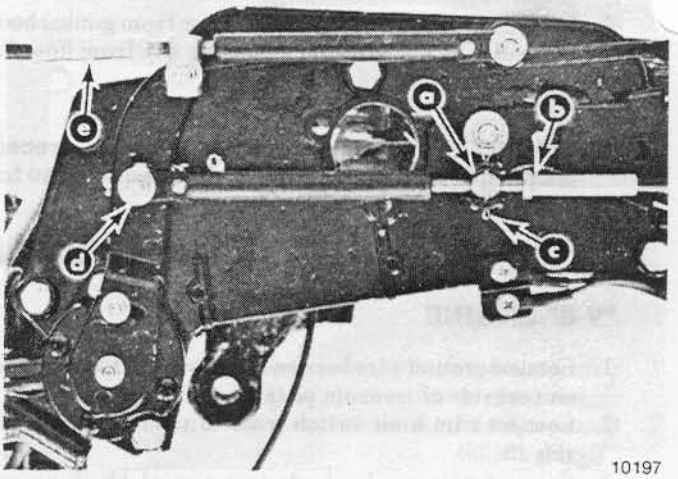
"IN-LINE" Engine Installations

a. Route drive unit shift cable (coming from gimbal housing) up left (port) side of engine and up to shift plate.
b. Place shift cable in "J" clip on engine flywheel housing cover and bend clip shut. (Figure 27)



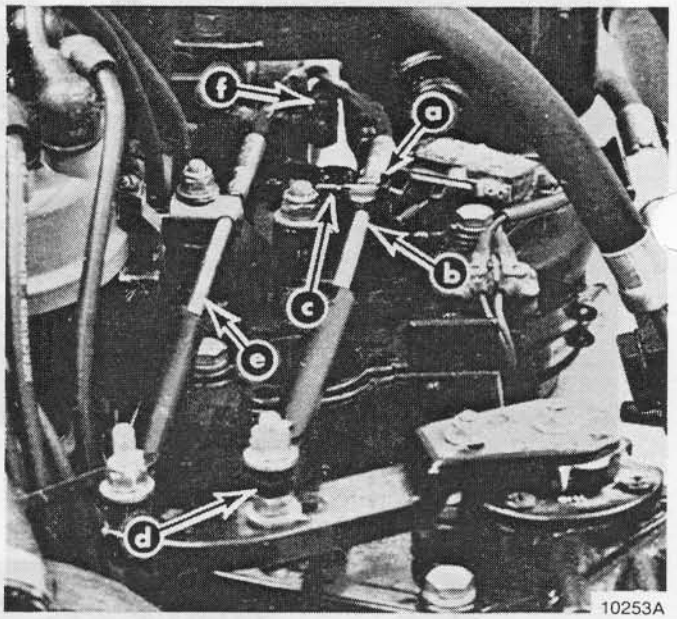
a - Flywheel Housing Cover b - "J" Clip

Figure 27. Drive Unit Shift Cable Fastened to Flywheel Housing



a - Cutout Lever Recess c - Cotter Pin
b - Drive Unit Shift Cable d - Adjustable Stud
e - Remote Control Cable

Figure 28. Attaching Shift Cables on "In-Lines"



a - Cutout Lever Recess d - Adjustable Stud
b - Drive Unit Shift Cable e - Remote Control Cable
c - Cotter Pin f - "J" Clip

Figure 29. Attaching Shift Cables on "V-8's"

2. Coat shift cutout lever recess and unthreaded portion of shift lever adjustable stud with Universal Joint Lubricant from U-Joint Grease Kit. (Figure 28 or 29)
3. Place shift cable brass barrel in shift cutout lever recess and cable end guide on shift lever adjustable stud. (Figure 28 or 29)
4. Install cotter pin in shift cutout lever recess and spread ears. (Figure 28 or 29)
5. Refer to "Transom Plate Adjustments", following.

Attaching Remote Control Shift Cable

1. Coat spacer and unthreaded portion of anchor studs with Universal Joint Lubricant. (Figure 28 or 29)
2. Route remote control shift cable as follows:

"V-8" Engine Installations

Route cable under starboard (right) exhaust elbow and thru "J" clip. Bend "J" clip closed around shift cables. Cables MUST BE free to move back-and-forth thru "J" clip.

"IN-LINE" Engine Installations

Cable may be installed from right (starboard) or left (port) side of boat. If shift cable is installed from right side, cable brass barrel is attached to shift lever anchor stud. If shift cable is installed from left side, cable brass barrel is attached to shift plate anchor stud.

3. Install remote control shift cable to anchor studs with washers and locking nuts positioned as shown in Figure 28 or 29.

IMPORTANT: DO NOT tighten elastic stop nuts against cable, as end guide and brass barrel must pivot freely on anchor studs.

NOTE: On "In-Line" installations, if shift cable is to be installed from the left (port) side, 2 remaining washers on shift plate anchor stud must be moved to shift lever anchor stud, and sleeve on shift lever anchor stud must be moved to shift plate anchor stud.

4. If cable adjustment is necessary refer to "Transom Plate Adjustments", following.

Attaching Power Steering Hydraulic Hoses

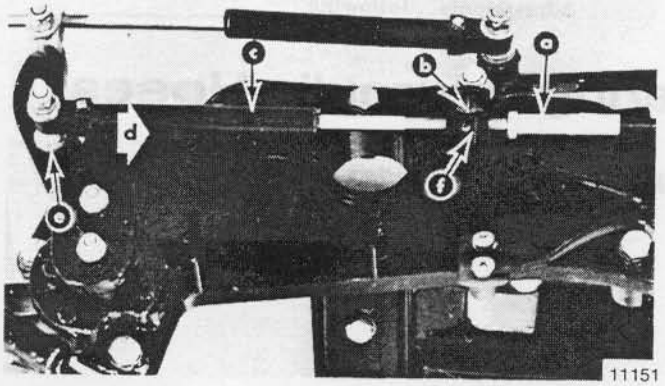
(Refer to "Power Steering" Section 6; See "Index".)

TRANSOM PLATE ADJUSTMENTS

Shift Cables and Cutout Switch Adjustments

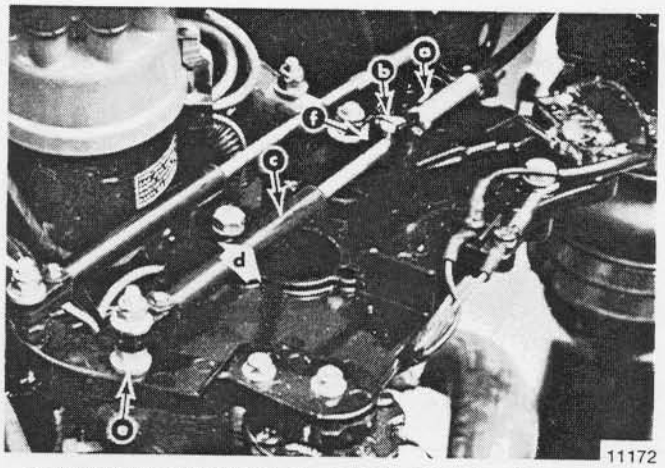
NOTE: When one cable requires adjustment, be sure to check other shift cable to ensure that total adjustments are correct.

IMPORTANT: If not already done, move shift lever adjustable stud (Figure 1) all-the-way to rear of slot in shift lever (rear of slot is toward reverse lock valve). Stud MUST BE in this position to properly adjust shift cables.



a - Drive Unit Shift Cable
b - Brass Barrel
c - Cable End Guide
d - Push in This Direction to Achieve Forward Gear Position
e - Adjustable Stud
f - Shift Cutout Lever Recess

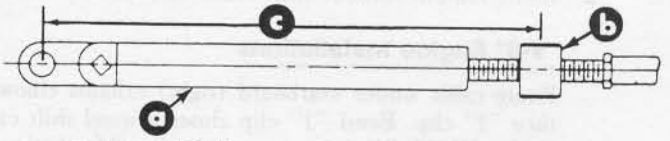
Figure 1. Adjusting "In-Line" Drive Unit Shift Cable



a - Drive Unit Shift Cable
b - Brass Barrel
c - Cable End Guide
d - Push in This Direction to Achieve Forward Gear Position
e - Adjustable Stud
f - Shift Cutout Lever Recess

Figure 2. Adjusting "V-8" Drive Unit Shift Cable

1. Remove drive unit shift cable from anchor stud and recess. (Figure 1 or 2)
2. Shift drive unit into full forward gear position by pushing cable end guide toward brass barrel as far as it will go. While shifting, turn propeller shaft counterclockwise until shaft stops (to assure full clutch engagement).

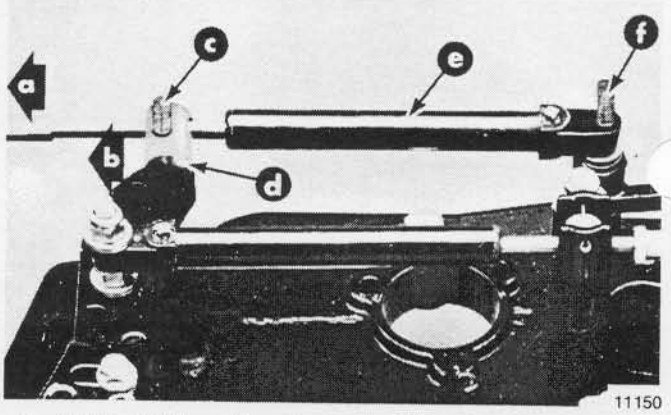


a - Cable End Guide b - Brass Barrel c - 6" (15.2cm)

Figure 3. Centerline to Centerline [6" (15.2cm)]

3. Check that distance from centerline of brass barrel to centerline of guide mounting hole is exactly 6" (15.2cm). (Figure 3) Readjust brass barrel to achieve this dimension.
4. Reinstall drive unit shift cable to anchor stud and recess. Install cotter pin to recess and elastic stop nut and washer to anchor stud. Tighten nuts until they bottom against flat washers, then back off ½-turn.

CAUTION: DO NOT tighten elastic stop nuts securely, as cable end guide and brass barrel MUST pivot freely.



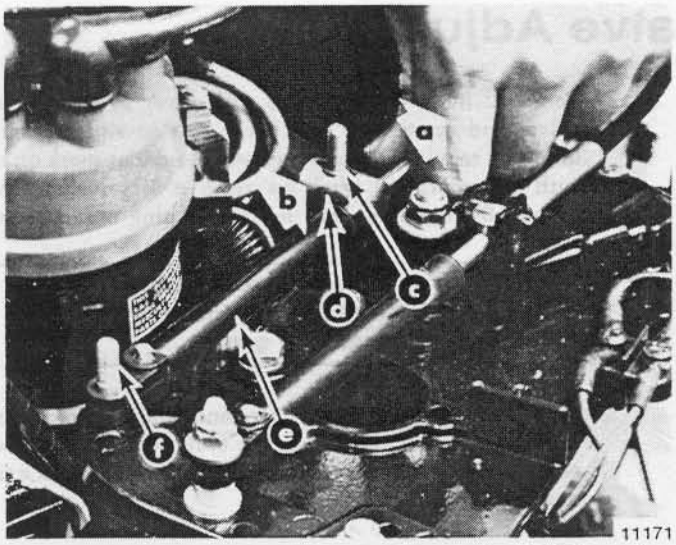
a - Lightly Pull Brass Barrel away from End Guide before Adjusting Cable
b - Adjust Cable Brass Barrel to Align with Anchor Stud, Then Back Off 4 Turns in This Direction
c - Shift Lever Anchor Stud
d - Cable Brass Barrel
e - Cable End Guide
f - Shift Plate Anchor Stud

Figure 4. Adjusting "In-Line" Remote Control Shift Cable

5. Remove remote control shift cable from both anchor studs. (Figure 4 or 5)

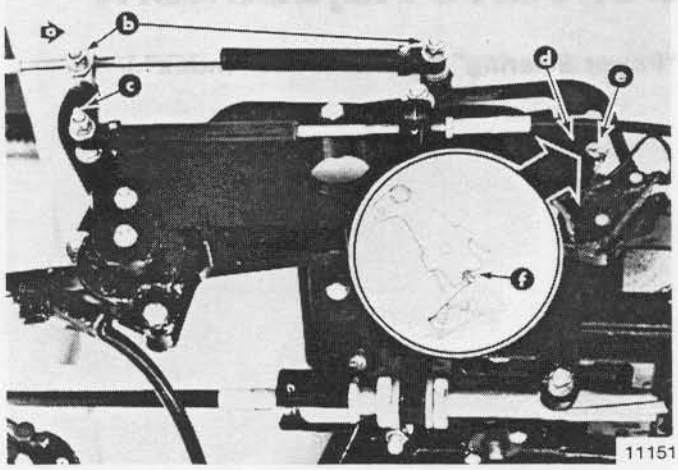
IMPORTANT: On "In-Line" installations, if shift cable is installed from the left (port) side, position 2 washers on shift lever anchor stud and the sleeve on shift plate anchor stud. (Figure 4)

6. Lightly pull cable end guide away from cable brass barrel to eliminate slack in cable.
7. Adjust brass barrel on shift cable so that hole in brass barrel and cable end guide align with shift lever ancho stud and shift plate anchor stud.
8. After cable attaching holes have been aligned with anchor studs, back brass barrel off 4 turns (away from cable end guide). (Figure 4 or 5)



a - Lightly Pull Brass Barrel away from End Guide before Adjusting Cable
b - Adjust Cable Brass Barrel to Align with Anchor Stud, Then Back Off 4 Turns in This Direction
c - Shift Lever Anchor Stud
d - Cable Brass Barrel
e - Cable End Guide
f - Shift Plate Anchor Stud

Figure 5. Adjusting "V-8" Remote Control Shift Cable

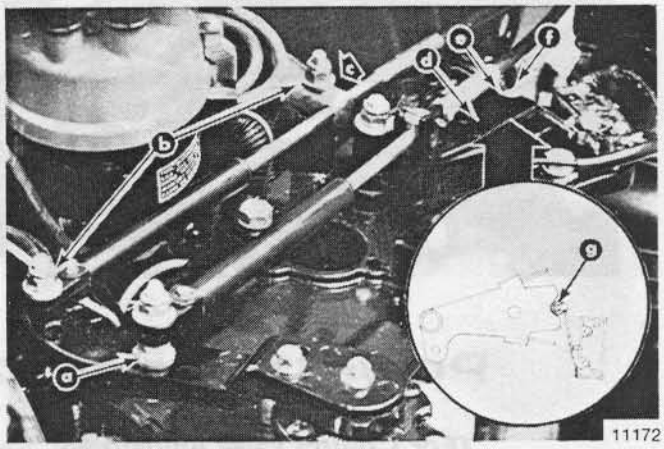


a - Turn Brass Barrel in This Direction, if Necessary, to Center Shift Cutout Lever
b - Flat Washers and Elastic Stop Nuts
c - Shift Lever Adjustable Stud
d - Shift Cutout Lever
e - Shift Cutout Switch Arm Roller
f - Roller Centered

Figure 6. Checking and Adjusting "In-Line" Shift Cutout Lever Position

9. Place shift cable in position on anchor studs. Be sure that spacer is in place on shift anchor stud.
10. Move remote control shift handle to full reverse position. While shifting, turn propeller shaft clockwise until shaft stops, ensuring full clutch engagement.
11. Check shift cutout lever position. (Figure 6 or 7) If lever is deflected from its neutral position (roller on shift cutout switch arm not centered in shift cutout lever detent), adjust remote control shift cable brass barrel one turn at a time (4 turns maximum) toward cable end guide until roller is centered.
12. Secure shift cable to anchor studs with flat washers and elastic stop nuts. (Figure 6 or 7) Tighten nuts until they bottom against flat washers, then back-off ¼-turn.

CAUTION: DO NOT tighten elastic stop nuts securely, as cable end guide and brass barrel MUST pivot freely.



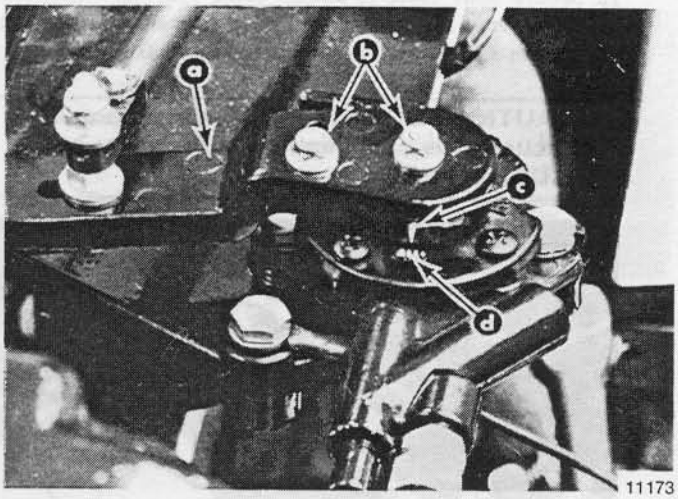
a - Shift Lever Adjustable Stud
b - Flat Washers and Elastic Stop Nuts
c - Turn Brass Barrel in This Direction, if Necessary, to Center Shift Cutout Lever
d - Shift Cutout Lever
e - Detent
f - Shift Cutout Switch Arm Roller
g - Roller Centered

Figure 7. Checking and Adjusting "V-8" Shift Cutout Lever Position

13. Perform the following check, to determine if shift lever adjustable stud requires adjustment. Adjust if necessary (use "a" or "b", following).
    a. Boat out of water and engine stopped - check and adjustment: Move remote control shift handle to neutral position, then slowly move handle into reverse position until throttle just begins to open. Turn propeller shaft to lock. If clutch does not engage, loosen shift lever adjustable stud. (Figure 6 or 7) Move stud toward front of slot until firm clutch engagement is achieved, then retighten stud. DO NOT move adjustable stud so far that shift cutout lever is deflected from its neutral position when remote control shift handle is moved to full reverse position.
    b. Boat in water and engine running - check: Move remote control shift handle into reverse position. Reverse clutch should engage before throttle begins to open. If throttle opens before reverse clutch engages, refer to Step 13a, preceding, and adjust shift lever adjustable stud.

Reverse Lock Valve Adjustment

1. Move remote control shift handle to full reverse position while, simultaneously, turning propeller shaft clockwise, thus ensuring full clutch engagement.



2. Loosen 2 nuts, which secure shift lever to reverse lo valve, and move rear nut (over slot in shift lever) i direction required to line up raised triangular mark on cam with second raised mark on reverse lock valve cover. (Figure 8) Retighten shift lever attaching nuts securely.

CAUTION: If reverse lock valve is over-adjusted, drive unit may be locked in "down" position while in neutral gear.

3. With boat in water and engine running, operate drive unit in reverse gear. If drive trails out (will not hold in "down" position), over-adjust reverse lock valve one mark at a time until drive unit holds.

a - Shift Lever
b - Shift Lever Attaching Nuts
c - Triangular Mark on Cam
d - Second Raised Mark on Cover

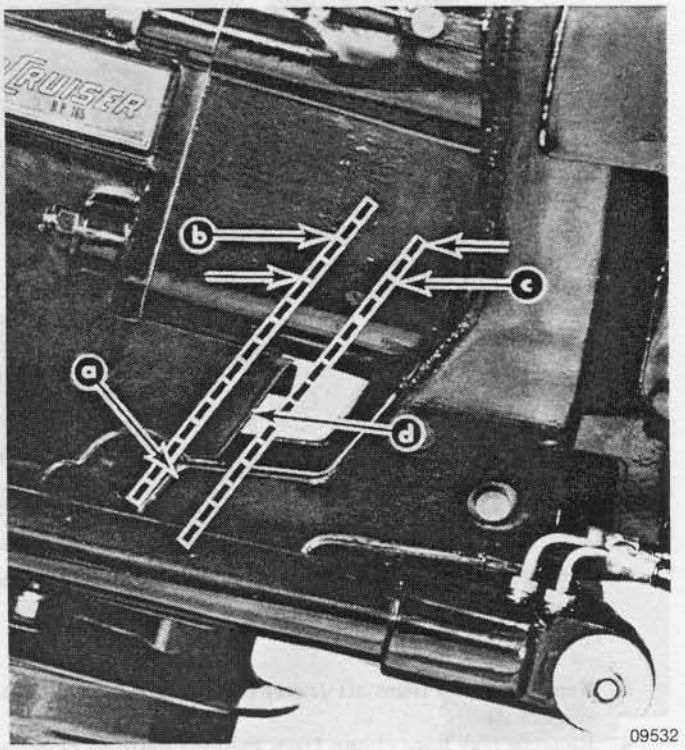
Figure 8. Adjusting Reverse Lock Valve

Power Steering Control Valve Adjustment

(For Control Valve Adjustment, Refer to "Power Steering" Section 6; See "Index".)

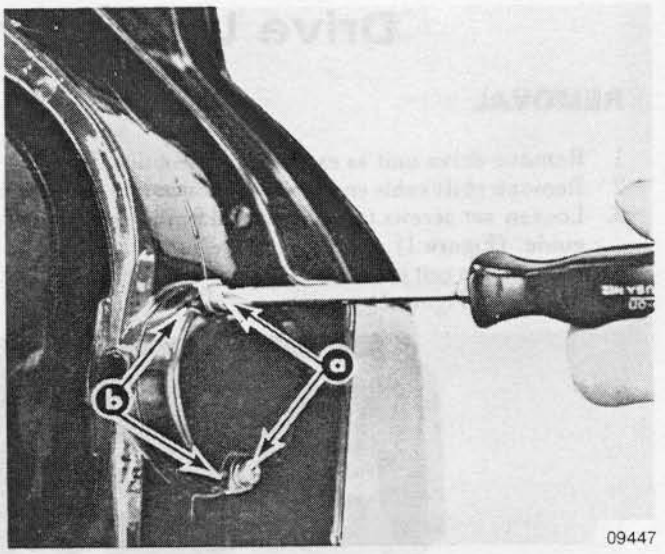
Trim Limit Switch Adjustment

Limiting drive unit outward trim travel is necessary to ensure safe control of boat at high speeds and to prevent damage to drive unit or trim cylinder because of lost side support to drive unit.



a - Gimbal Ring Support Boss
b - 3/4" (19mm)
c - 1" (25.4mm)
d - Drive Shaft Housing Edge

Figure 9. Trim Limit Switch Adjustment



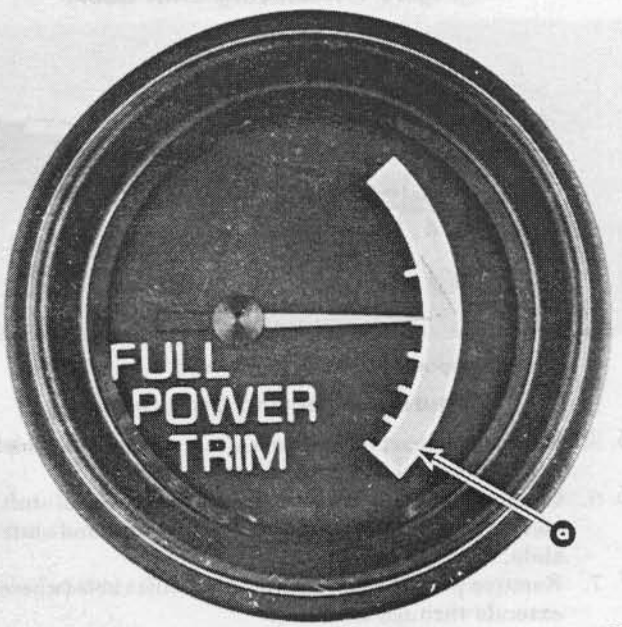
a - Retaining Screws
b - Adjusting Slots

Figure 10. Trim Switch and/or Sender Assembly

1. Trim drive unit upward until front edge drive shaft housing of drive unit is protruding ¾" to 1" (19mm to 25.4mm) into gimbal ring support bosses, as shown in Figure 9.
2. Disconnect limit switch leads from harness (inside boat) and connect leads to continuity meter.
3. Loosen retaining screws which hold trim limit switch. (Figure 10)
4. Switch is normally in closed circuit position. Rotate switch housing in either direction until switch circuit just opens.
5. Tighten retaining screws and reconnect switch leads to complete adjustment.

Trim Position Sender Adjustment

1. Place stern drive unit in full "down" trim position.
2. Loosen 2 retaining screws (Figure 10) which hold indicator sender.
3. Turn ignition key to "Run" position.
4. Rotate sender housing in either direction to position instrument needle on bottom of green arc. (Figure 11)
5. Tighten retaining screws. Recheck instrument reading and turn ignition key to "Off" position.



a - Green Arc

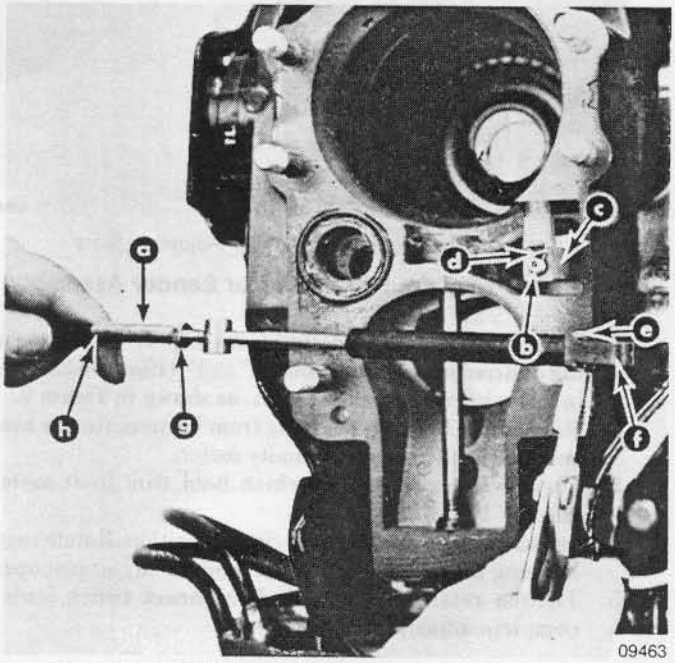
Figure 11. Trim Indicator Gauge

TRANSOM PLATE COMPONENT REPLACEMENT

Drive Unit Shift Cable Replacement

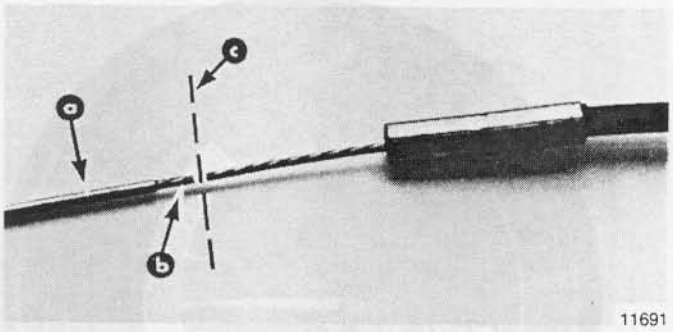
REMOVAL

1. Remove drive unit as explained in Section 3.
2. Remove shift cable end from anchor points on shift plate.
3. Loosen set screws from cable end guide and remove end guide. (Figure 1)
4. Loosen jam nut on metal cable end and turn metal end out of cable. (Figure 1)



a - Metal Cable End
b - Set Screw
c - Cable Slide
d - Lockwire
e - Set Screws (One Each Side)
f - End Guide
g - Jam Nut
h - Shift Cable

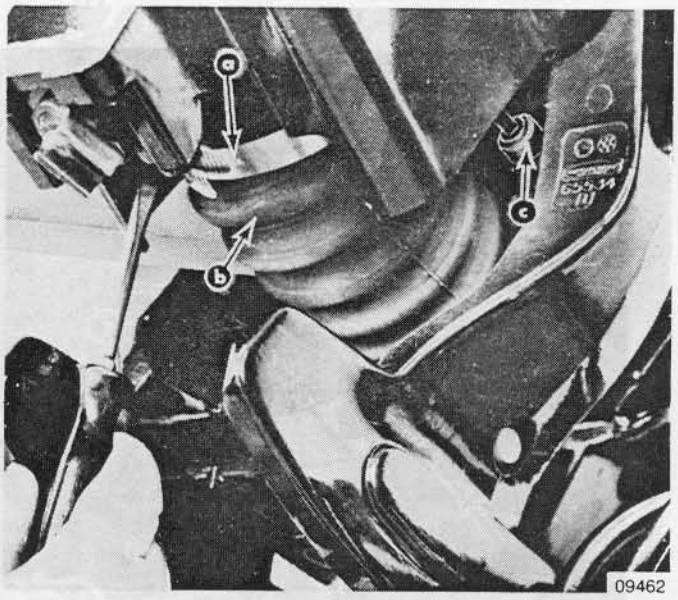
Figure 1. Removing Shift Cable



a - Support Tube b - Core Wire c - Cut Here

Figure 2. Removing Support Tube

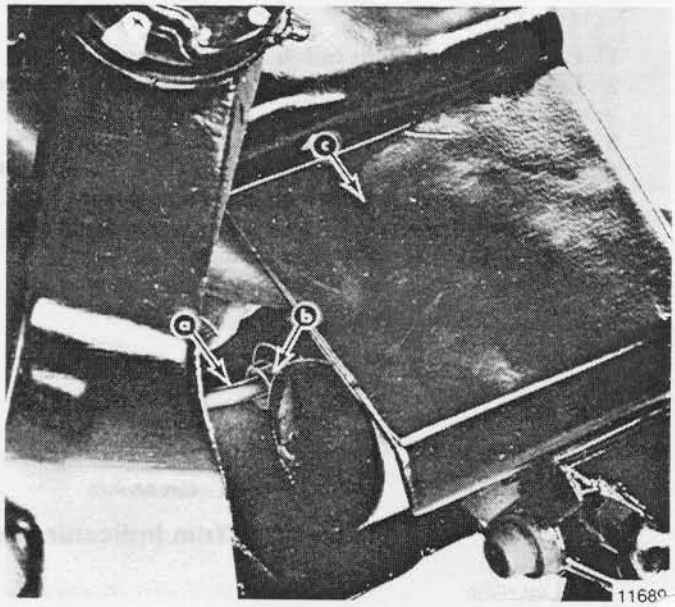
5. Remove support tube (Figure 2) by cutting core wire below support tube with side cutters.
6. Cut lockwire and remove set screw from end of shift cable slide. (Figure 1) Remove inner core wire and shift cable slide.
7. Remove protective wrapping from shift cable (where cable extends through transom).



a - Clamp b - Exhaust Bellows c - Shift Bellows Aft Clamp

Figure 3. Removing Clamps from Bellows

8. Remove clamp from aft (rear) end of shift cable bellows (Figure 3)
9. Remove rear hose clamp from exhaust bellows (Figure 3) (if equipped) and tilt bell housing up as far as possible. This is to allow greater accessibility to shift cable retainer nut.
10. Remove shift cable outer casing from bell housing by turning retainer nut and cable at the same time. (Figure 4)
11. Remove outer cable from boat.



a - Shift Cable b - Retainer Nut c - Bell Housing

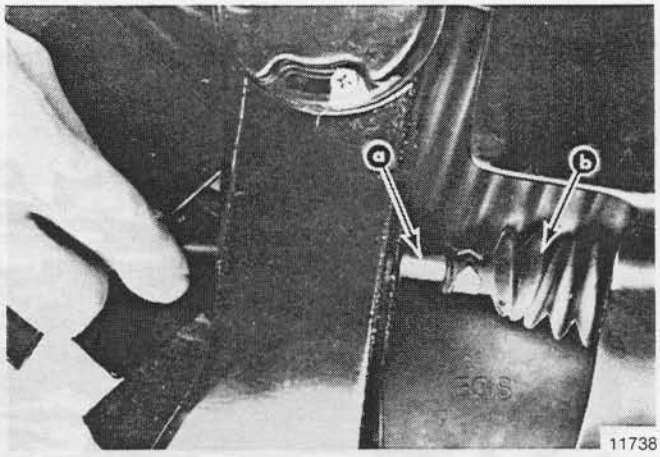
Figure 4. Removing Shift Cable from Bell Housing

INSPECTION

Check total shift cable assembly for cuts, damaged threads, bent condition and unraveling at end of wire. Replace all damaged parts. Also inspect shift cable bellows for possible leaks.

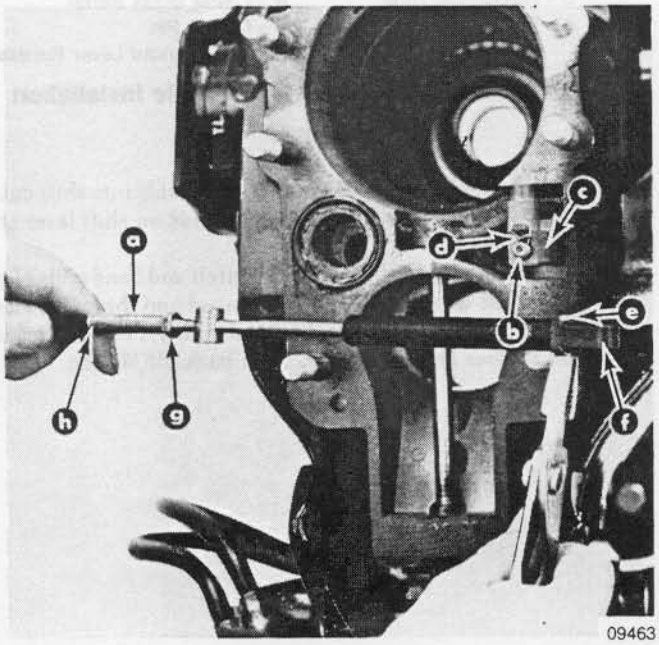
INSTALLATION

1. Insert outer cable metal end thru aft end of shift cable bellows and into boat, using Multipurpose Lubricant to ease installation. (Figure 5)
2. Tilt bell housing up as far as possible and insert outer cable end (with connector) thru bell housing opening. (Figure 4)
3. Apply Perfect Seal to threads of brass retainer nut and turn cable and retainer nut (together) into bell housing. Tighten retainer nut securely.



a - Outer Cable Metal End b - Aft End of Shift Bellows

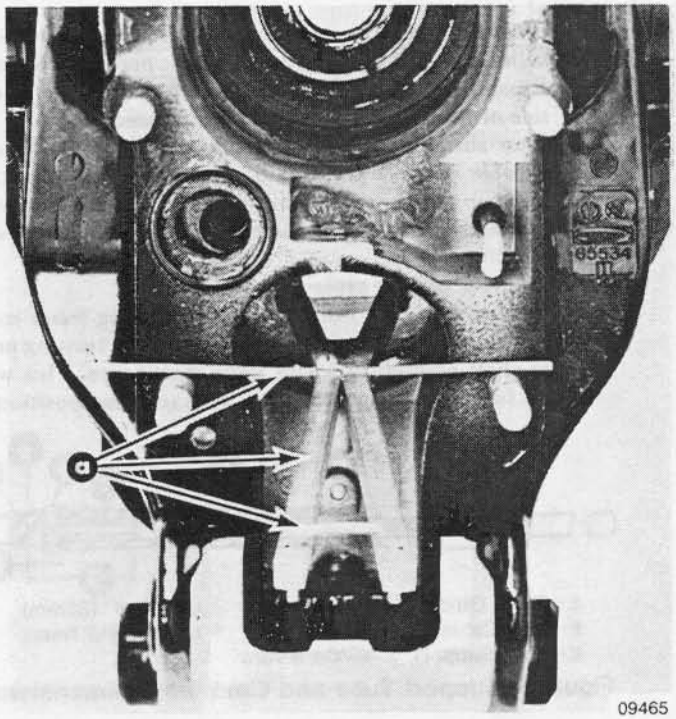
Figure 5. Installing Outer Cable



a - Metal Cable End d - Lockwire f - End Guide
b - Set Screw e - Set Screws g - Jam Nut
c - Cable Slide (One Each Side) h - Shift Cable

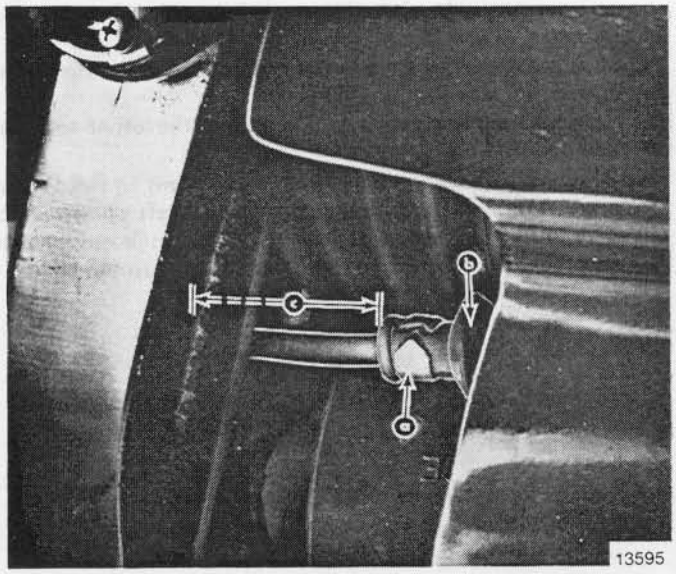
Figure 6. Installing Shift Cable to Bell Housing

4. Turn cable end into outer cable until it bottoms-out, then tighten jam nut. (Figure 6)
5. Install inner core wire through cable slide and into outer cable. (Figure 6)
6. Install allen set screw in cable slide. (Figure 6) Tighten set screw securely, then back off approximately ¼-turn. The screw must be loose enough to permit core wire to turn or rotate freely, but tight enough to minimize end play between cable and cable slide. Secure screw with lockwire.



a - Expander Tool (C-91-45497A1) (3 Pieces)

Figure 7. Installing Exhaust Bellows to Bell Housing



a - Aft Clamp b - Shift Cable Bellows
c - This Dimension Is 2" (51mm)

Figure 8. Installing Aft Clamp of Shift Cable Bellows

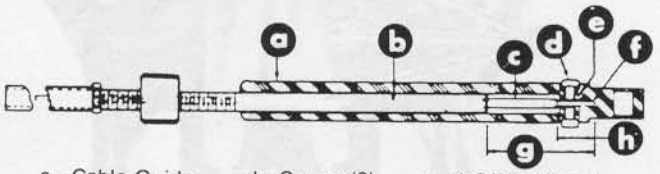
7. Install aft end of exhaust bellows (if so equipped).

NOTE: Before installing end of exhaust bellows to bell housing, position grounding clip (end with holes inward) over end of bellows.

a. If shifting mechanism is not in bell housing, install exhaust bellows on bell housing with Expander Tool (C-91-45497A1). Tighten hose clamp securely. (Figure 7)

b. If shifting mechanism is in bell housing, install exhaust bellows on bell housing by removing pivot screw from Expander Tool (C-91-45497A1) and positioning each side of tool on either side of shifting mechanism.

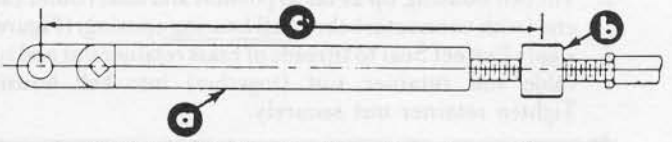
8. Position shift cable bellows approximately 2" (51mm) from cable connector (located in bell housing). Install small clamp on rear end of shift cable bellows and squeeze clamps securely to prevent water from entering bellows. (Figure 8)
9. Install drive unit as explained in Section 3.
10. Shift drive unit into full forward by pushing inner core wire as far into outer cable as possible, while turning propeller shaft counterclockwise until shaft stops. This will assure full clutch engagement in forward gear position.



a - Cable Guide
b - Shift Cable
c - Tube Support
d - Screw (2)
e - Anchor
f - Core Wire
g - 1-3/8" (35mm)
h - 1/2" (12.7mm)

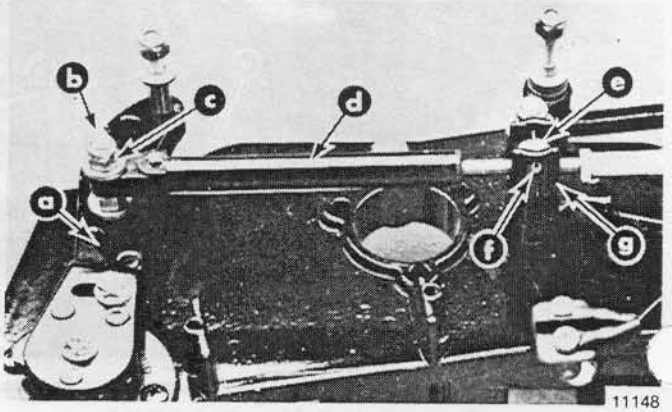
Figure 9. Support Tube and Core Wire Dimensions

11. Check the length that inner core wire extends from outer cable guide insert. (Figure 9) If the inner core extends greater than 1⅜" (35mm), cut excess from extending end.
12. Slide support tube over core wire so that ½" (12.7mm) of core wire is showing. (Figure 9) It is secured to core wire by crimping end.
13. Slide cable end guide over end of cable, then thru cable anchor. (Figure 9)
14. Snug one anchor screw and tighten the other to secure core wire.
15. With cable end guide installed, shift unit in full forward gear. While shifting, turn propeller shaft counterclockwise until shaft stops, to assure full clutch engagement. Distance from centerline of brass barrel to centerline of cable end guide mounting hole must be exactly 6" (15.2 cm). (Figure 10) Readjust brass barrel to achieve this dimension.
16. Coat recess of cutout switch lever and shift cable anchor points with Multipurpose Lubricant.
17. Route shift cable as follows:
    a. "V-8's" - Route cable under right (starboard) exhaust elbow and thru "J" clip.
    b. "In-Lines" - Route cable in cable clamp (located on engine flywheel housing cover) and bend clamp shut.



a - Cable End Guide b - Brass Barrel c - 6"

Figure 10. Centerline to Centerline - 6" (15.2cm)



a - Shift Lever
b - Adjustable Stud
c - Elastic Stop Nut and Flat Washer
d - Cable End Guide
e - Cable Brass Barrel
f - Cotter Pin
g - Shift Cutout Lever Recess

Figure 11. Drive Unit Shift Cable Installation

18. Place brass barrel of drive unit shift cable into shift cutout lever recess and place cable end guide on shift lever stud. (Figure 11)
19. Insert cotter pin thru cutout switch and bend ends of pin.
20. Place flat washer on shift lever stud and thread on elastic stop nut. (Figure 11) Tighten nut until it bottoms against flat washer and end guide, then back off ¼-turn.

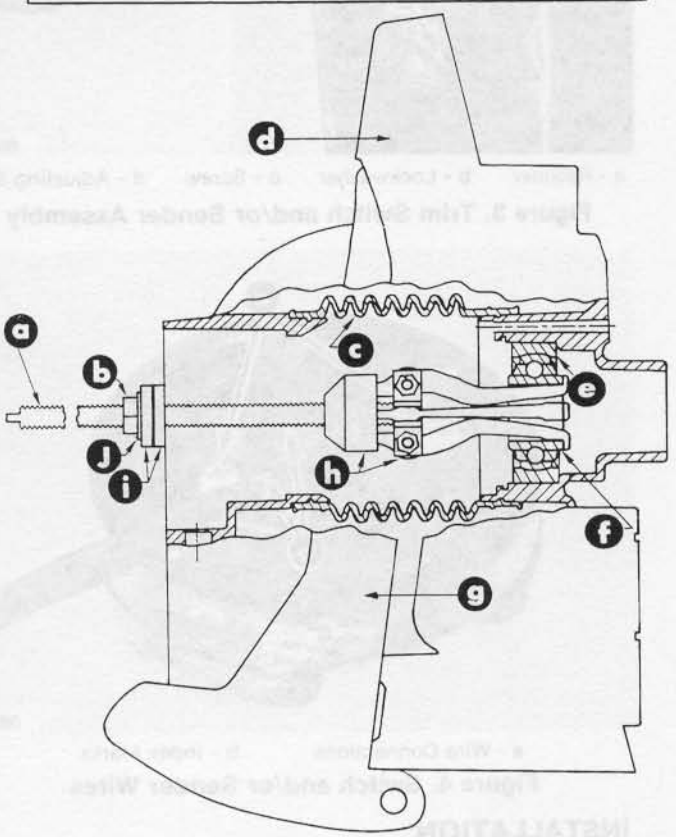
Gimbal Bearing Replacement

INSPECTION

1. Remove drive unit from bell housing, as explained in Section 3.
2. Reach thru bell housing and rotate bearing to check for rough spots. Pull and push on inner race to check for side wear. Any excessive movement is cause for replacement.

REMOVAL

CAUTION: Gimbal bearing may be damaged during removal. DO NOT remove bearing cartridge assembly, unless replacement is necessary. Replacement bearings come as an assembly with cartridge and must be replaced as an assembly.



a - Puller Shaft (C-91-31229)
b - Nut (C-11-24156)
c - Bellows
d - Gimbal Housing
e - Bearing Cartridge
f - Bearing Inner Race
g - Gimbal Ring
h - Slide Hammer Puller (C-91-34569A1)
i - Plate (2) (C-91-29310)
j - Washer (C-12-34961)

Figure 1. Removing Bearing Cartridge Assembly

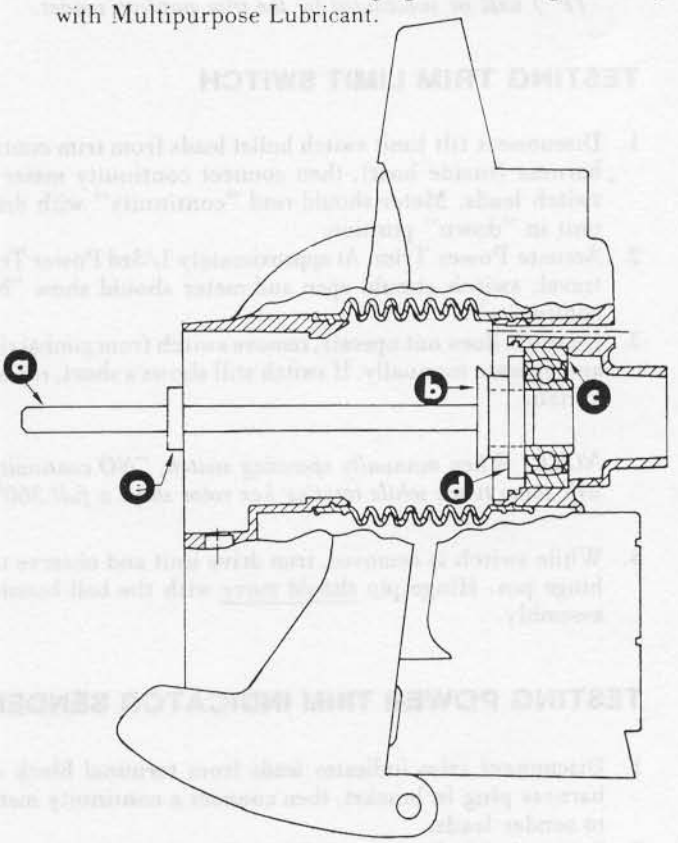
1. After removing drive unit, remove bearing cartridge assembly with tools as illustrated in Figure 1. Two Plates (C-91-29310) must be used. Position plates between top and middle studs (located on bell housing). Use 3-jaw puller from Slide Hammer Puller (C-91-34569A1).

   If bearing assembly is extra tight, it may be necessary to tap end of Puller Shaft (C-91-31229) with a mallet while turning Nut (C-11-24156).

NOTE: Older Bearing Removal and Installing Kits (C-91-31229A4) will need 5/8-18 threads cut in unthreaded portion of Puller Shaft (C-91-31229) to accept slide hammer 3-jaw puller and jaw spreader adaptor.

INSTALLATION

1. Lubricate outside of cartridge gimbal bearing assembly with Multipurpose Lubricant.



a - Driver Rod (C-91-37323)
b - Driver Head (C-91-32325)
c - Bearing Cartridge
d - Mandrel (C-91-30366)
e - Plate (C-91-29310)

Figure 2. Installing Bearing Cartridge Assembly

2. Install bearing cartridge assembly with tools illustrated in Figure 2. Bearing cartridge grease hole and tolerance ring opening must align with grease cavity hole in gimbal housing.
3. Insert Driver Head (C-91-32325) thru Mandrel (C-91-30366) and into inside diameter of bearing assembly.
4. Align bearing cartridge assembly with gimbal housing cavity. Place Plate (C-91-29310) between top and middle studs (on bell housing) as a pilot. Drive bearing cartridge assembly into gimbal housing cavity with a lead hammer or mallet.
5. Lubricate cartridge gimbal bearing with Pistoluber (C-91-37299), using ONLY Universal Joint or 2-4-C Lubricant thru grease fitting. Pump 40 full strokes [1 oz. (28g)] to adequately lubricate bearing.

   NOTE: Use Engine Alignment Shaft (C-91-48247 or C-91-57797A3) to align gimbal bearing after installation and check engine alignment.

6. Install drive unit as described in Section 3.

Trim Limit Switch and Trim Position Sender Replacement

NOTE: Trim limit switch (marked "TL") is located on port (left) side of gimbal ring, and trim position sender (marked "TP") is located on starboard (right) side of gimbal ring. If Power Package is not equipped with trim position gauge, an empty sender housing (which will NOT be marked with a "TP") will be substituted for the trim position sender.

TESTING TRIM LIMIT SWITCH

1. Disconnect tilt limit switch bullet leads from trim control harness (inside boat), then connect continuity meter to switch leads. Meter should read "continuity" with drive unit in "down" position.
2. Actuate Power Trim. At approximately 1/3rd Power Trim travel, switch should open and meter should show "NO continuity".
3. If switch does not operate, remove switch from gimbal ring and operate manually. If switch still shows a short, replace switch.

NOTE: When manually operating switch, "NO continuity" will show twice while rotating hex rotor shaft a full 360°.

4. While switch is removed, trim drive unit and observe the hinge pin. Hinge pin should move with the bell housing assembly.

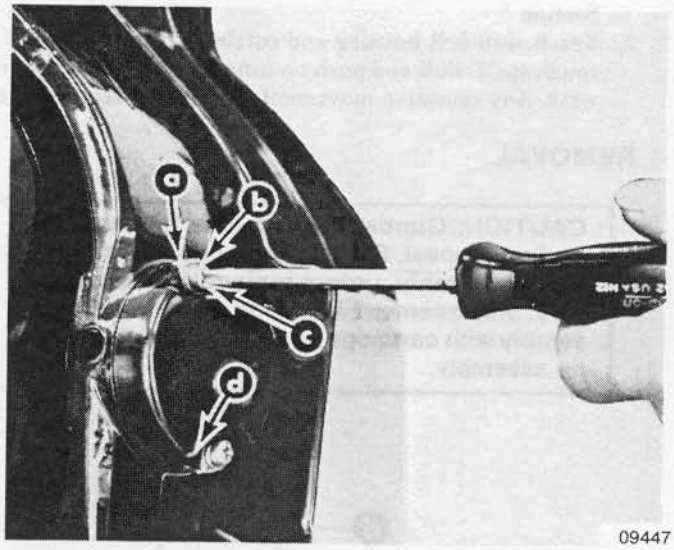
TESTING POWER TRIM INDICATOR SENDER

1. Disconnect trim indicator leads from terminal block on harness plug in bracket, then connect a continuity meter to sender leads.
2. Starting with drive unit in "down" position and trimming thru total range of travel, meter should indicate an even movement between zero and approximately 80 ohms for dual station sender and 160 ohms for single station sender.
3. Erratic or no needle movement is indication that replacement is necessary.
4. Remove trim indicator sender from gimbal ring.
5. Trim drive unit and observe the hinge pin. Hinge pin should move with the bell housing assembly.

NOTE: Further manual rotation of trim sender will carry resistance value beyond 160 ohms (or 80 for dual station). This is normal.

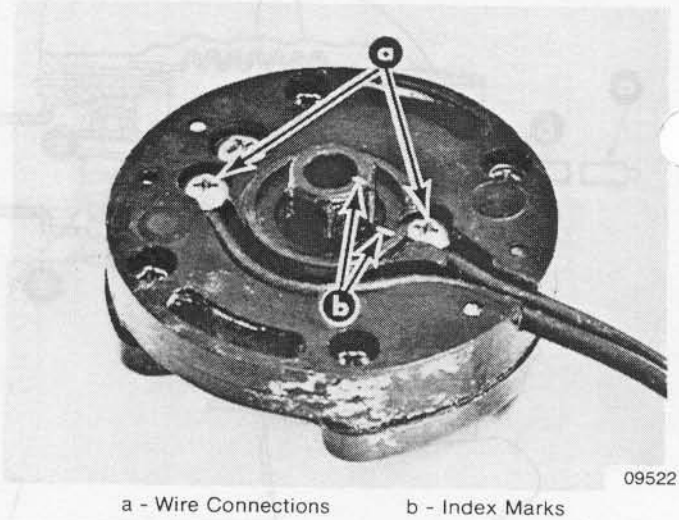
REMOVAL

1. Remove switch and/or sender from gimbal ring by removing 2 screws with lockwasher and retainer. (Figure 3)
2. Remove 2 wires from back of switch and/or sender. (Figure 4)



a - Retainer b - Lockwasher c - Screw d - Adjusting Slot

Figure 3. Trim Switch and/or Sender Assembly



a - Wire Connections b - Index Marks

Figure 4. Switch and/or Sender Wires

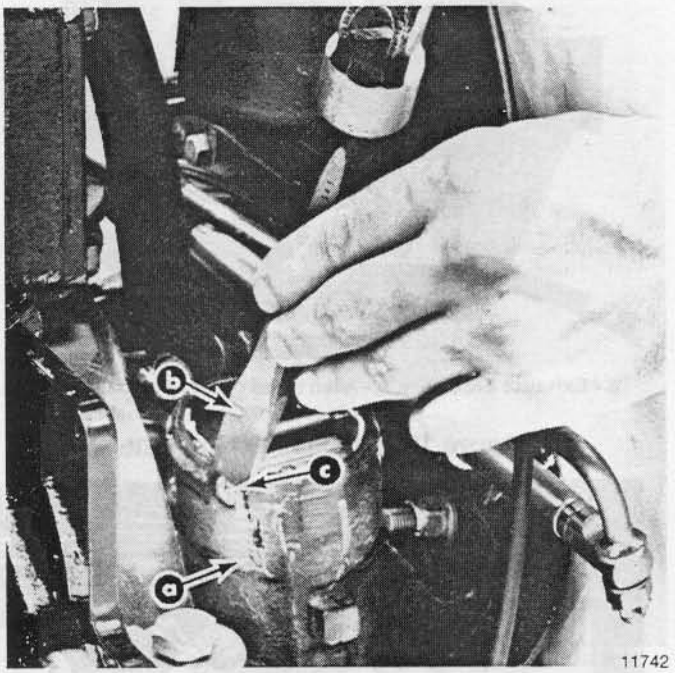
INSTALLATION

1. Fasten wires securely to back of switch and/or sender. (Figure 4) Tighten retaining screws securely. Fill grooves with Anti-Corrosion Lubricant. Be sure that screws are completely covered.
2. Align slots in insulator and position insulator on back of housing assembly.
3. Align rotor index with housing index (Figure 4) and install on gimbal ring with bell housing in "down" position.
4. Install 2 screws with lockwasher and retainers. (Figure 3)
5. Reconnect leads (inside boat) after final adjustment.
6. For trim limit switch adjustment and/or trim sender adjustments, refer to "Transom Plate Adjustments" (see "Index").

Exhaust Elbow and Shutter Replacement

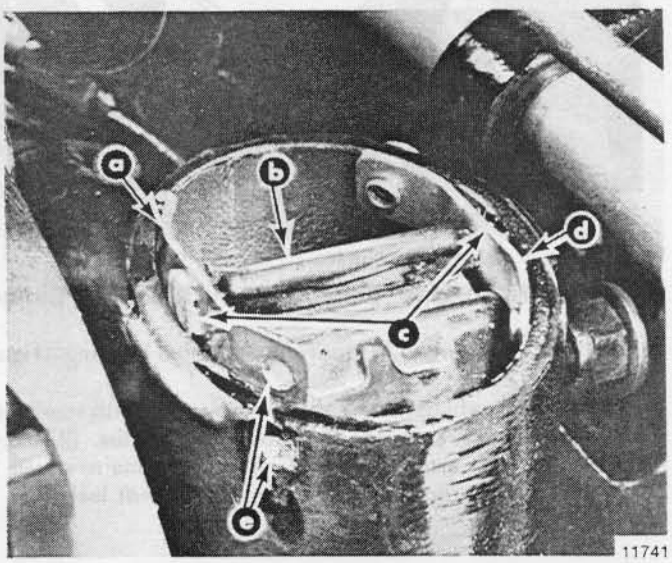
"IN-LINE" ENGINE SHUTTER REPLACEMENT

1. Loosen hose clamps on rubber exhaust bellows and remove bellows.
2. Chisel rivets away from one (most easily accessible) support member and remove support member. (Figure 5)



a - Exhaust Elbow b - Chisel c - Rivet

Figure 5. Removing Shutter



a - Support Member Removed in Disassembly
b - Shutter
c - Silicone Sealer
d - Support Member
e - Align These Holes

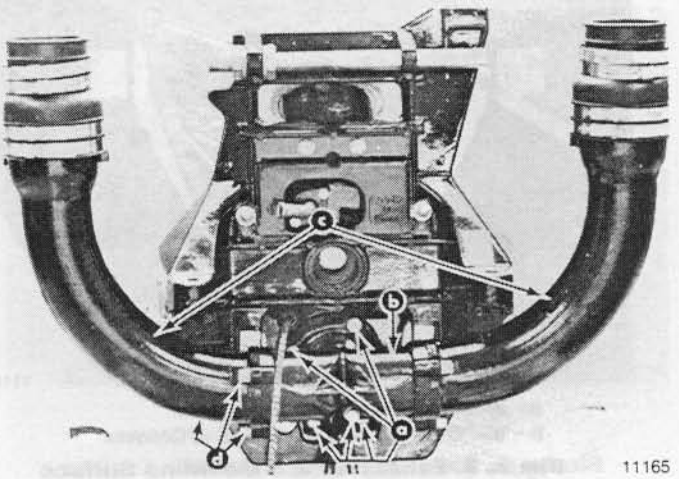
Figure 6. Replacing Shutter

3. Apply silicone sealer to one end of new shutter, then place end in support member that was removed in Step 2.
4. Bend tongues of shutter away from center support bar and point them down exhaust elbow. Place other end of shutter (after applying silicone to end) in support member (still in exhaust elbow), while positioning shutter assembly so that mounting holes line up. (Figure 6)
5. Secure support member with 10-32x½ round head screws and nuts. Be sure that head of screw is to the outside of exhaust elbow.
6. Place hose clamps over both ends of rubber exhaust bellows, then reposition between engine and lower exhaust elbows and tighten hose clamps.

"V-8" ENGINE SHUTTER REPLACEMENT

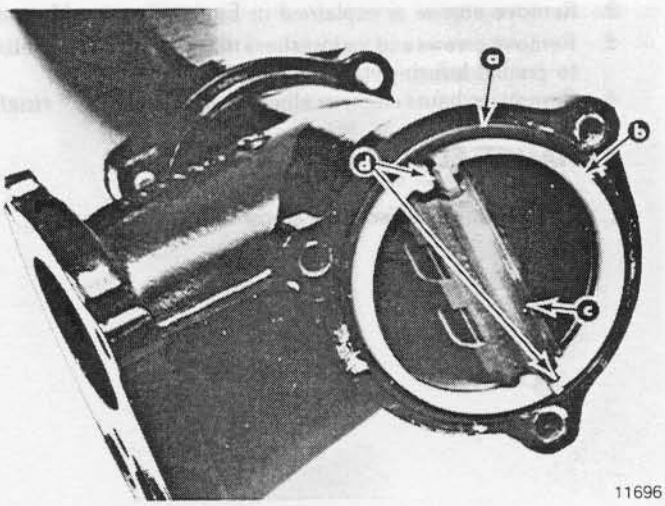
NOTE: If a long allen wrench is available, and limits of engine compartment allow access to exhaust elbow allen screws, then removal of drive unit and engine is not necessary.

1. Remove drive unit as explained in Section 3.
2. Remove engine as explained in Engine Service Manual.
3. Remove exhaust assembly from gimbal housing by removing 4 hex head bolts and allen head bolt (Figure 7), then remove exhaust elbows from exhaust separator by removing allen head screws. (Figure 7)



a - Cap Screw Securing Exhaust Assembly to Transom Plate
b - Exhaust Separator
c - Exhaust Elbows
d - Allen Head Screws Securing Elbow to Separator

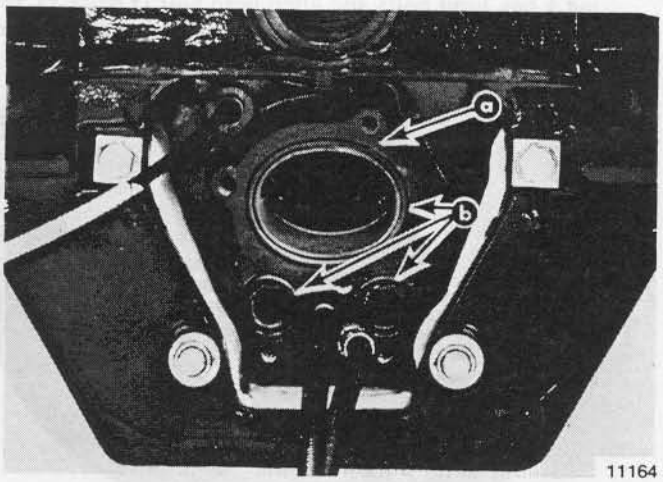
Figure 7. Exhaust Assembly



a - "O" Ring b - Nylon Insert c - Shutter d - Slot (Facing Out)

Figure 8. Replacing Shutter

4. Remove "O" rings, shutter assembly and nylon insert from exhaust elbow. (Figure 8)
5. Push shutter retainer into position inside exhaust elbow. (Figure 8) Be sure that slots are facing out.
6. Install new shutter so that shutter tongues are facing into separator, as shown in Figure 8.
7. Install new "O" rings (Figure 8) between separator and lower exhaust elbows. Secure separator and elbows together with allen head screws [torqued to 20-25 ft. lbs. (2.76-3.45mkg)].
8. Install exhaust assembly to gimbal housing, as follows:
   a. Check mating surfaces on exhaust separator and gimbal housing to ensure that they are clean and that "O" rings are seated properly in grooves. (Figure 9)
   b. Place exhaust elbows and separator assembly in position on gimbal housing and secure with 4 hex head bolts, allen head bolt and 5 lockwashers. (Figure 7) Torque screws to 20-25 ft. lbs.
9. Install engine as explained in Engine Service Manual.
10. Install drive unit as explained in Section 3 of this Service Manual.



a - Mating Surface Must Be Clean
b - "O" Rings Must Be Seated in Grooves

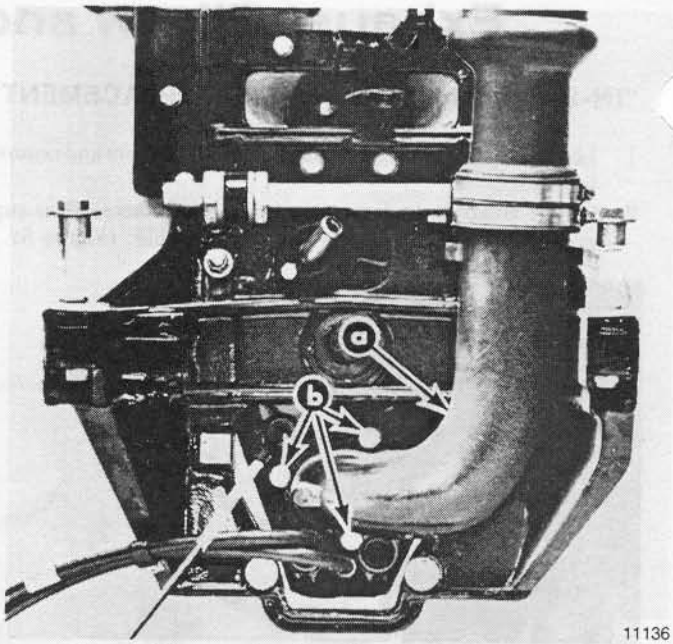
Figure 9. Exhaust Elbow Mounting Surface

EXHAUST ELBOW REMOVAL

1. Remove drive unit as explained in Section 3.
2. Remove engine as explained in Engine Service Manual.
3. Remove screws and lockwashers that secure exhaust elbow to gimbal housing. (Figure 7 or 10)
4. Remove exhaust elbow or elbow assembly and "O" ring(s).

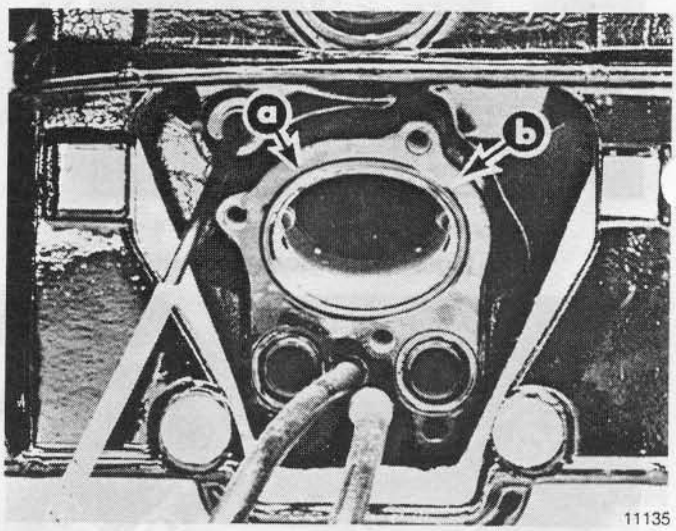
EXHAUST ELBOW INSTALLATION

1. Clean mating surfaces on elbow and gimbal housing.



a - Exhaust Elbow b - Allen Head or Hex Head Cap Screws (Secure Elbow to Gimbal Housing)

Figure 10. "In-Line" Exhaust Elbow



a - Mating Surface b - "O" Ring

Figure 11. "In-Line" Exhaust Elbow Mounting Surface

2. Place "O" ring(s) in groove(s) of gimbal housing. (Figure 9 or 11)
3. Reinstall exhaust elbow or elbow assembly with screws and lockwashers, torquing them to 20-25 ft. lbs. (2.76-3.46 mkg). Be certain that "O" ring(s) remain seated in groove(s), properly sealing joint to prevent leakage.

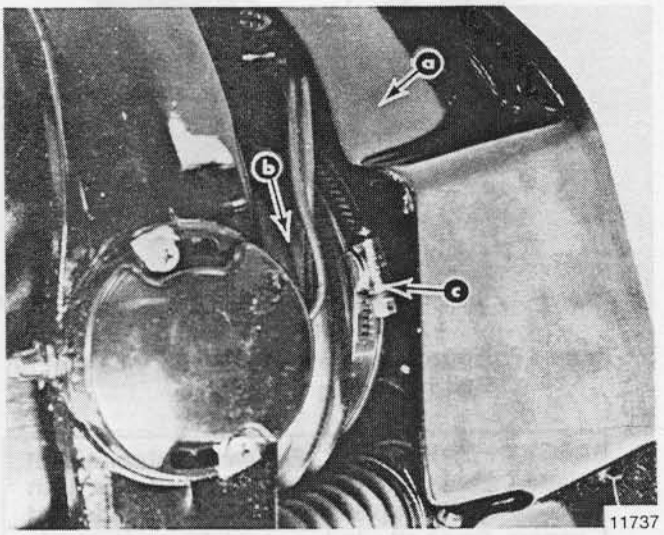
Bell Housing and Bellows Replacement

REMOVAL and DISASSEMBLY

1. Remove drive unit as explained in Section 3.
2. Remove shift cable inner core as explained in "Drive Unit Shift Cable Replacement", preceding, then loosen rear clamp of shift cable bellows.

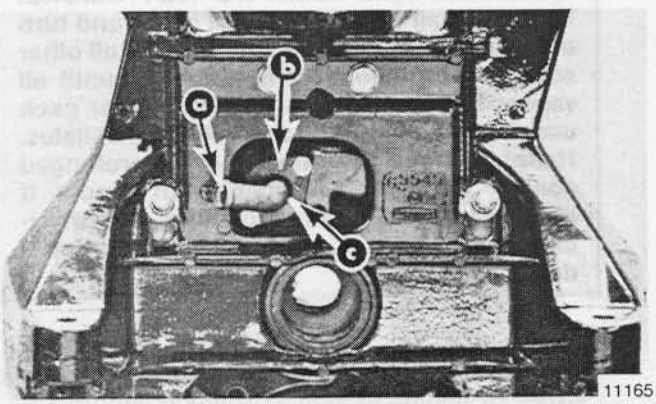
   NOTE: If bellows is being replaced, bellows and support wire (inside it) can be cut to aid in removal of bell housing.

3. Remove screws, which secure trim limit switch and trim position sender, and remove from gimbal ring.
4. Position switch and sender assembly so that they will not become damaged during further disassembly.
5. Remove 2 screws, water tube cover and rubber bushing (located at front of gimbal housing, inside boat) and push water tube thru gimbal housing. (Figure 13)
6. Remove gimbal ring to bell housing hinge pins (one each side) with Hinge Pin Tool (C-91-78310). (Figure 14)



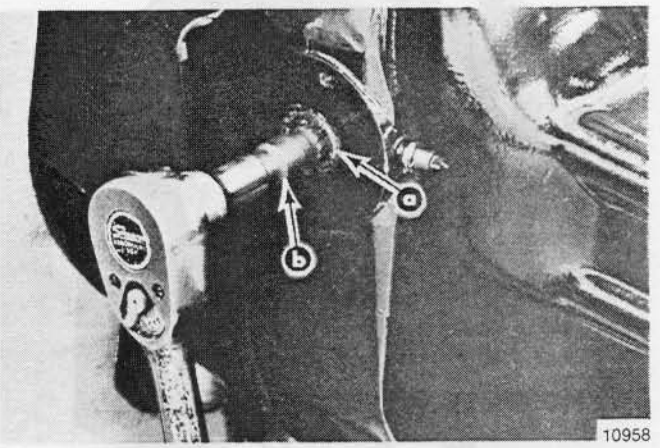
a - Gimbal Housing b - Universal Joint Bellows c - Clamp

Figure 12. Removing Universal Joint Bellows



a - Water Tube b - Cover c - Rubber Bushing (under Cover)

Figure 13. Removing Water Tube

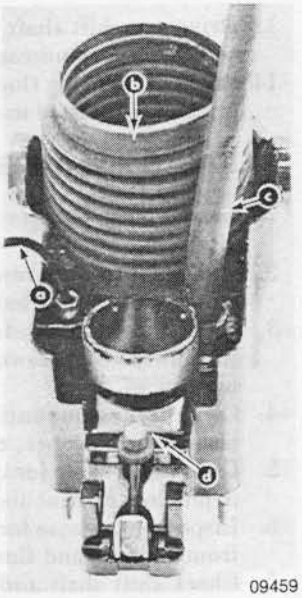


a - Hinge Pin b - Hinge Pin Tool (C-91-78310)

Figure 14. Removing Hinge Pins

NOTE: It may be necessary to apply heat to hinge pins to break down Loctite which was used in assembly. Use care when applying heat so that anti-friction washers (between bell housing and gimbal ring) are not damaged.

7. Pull bell housing from gimbal ring as far as possible. Loosen front clamp and remove gimbal housing end of universal joint bellows. (Figure 12) If equipped, loosen rear clamp of exhaust bellows and remove end from bell housing.
8. Remove bell housing assembly.
9. Remove universal joint bellows and water hose by loosening clamps and separating them from bell housing. (Figure 15)
10. Remove shift cable by turning retainer nut and cable at the same time. (Figure 15)
11. Remove rubber bumper, if replacement is necessary. (Figure 15)

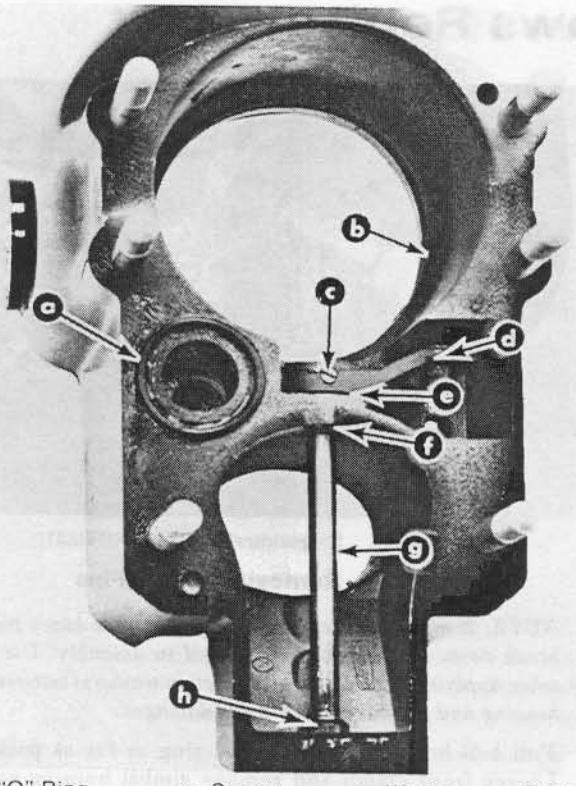


a - Shift Cable
b - Universal Joint Bellows
c - Water Tube
d - Rubber Bumper

Figure 15. Front End of Bell Housing

12. Remove shift lever screw, then remove shift lever, washer and shift shaft. (Figure 16)

NOTE: It may be necessary to apply heat to shift lever screw to break down Loctite which was used in assembly. Use care when applying heat so that shift shaft oil seal (Figure 16) is not damaged.



a - "O" Ring
b - Rubber Gasket
c - Screw
d - Shift Lever
e - Washer
f - Oil Seal
g - Shift Shaft
h - Bushing

Figure 16. Aft End of Bell Housing

13. Drive out shift shaft oil seal and bushing (Figure 16), if replacement is necessary.
14. Remove "O" ring (located around water passage) and rubber gasket (located in universal joint passage). (Figure 16)

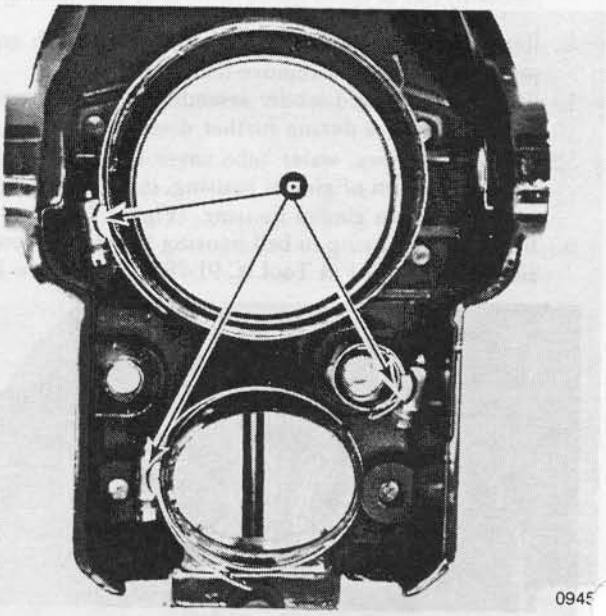
CLEANING and INSPECTION

1. Clean all metal parts in solvent and dry with compressed air.
2. If bellows is to be re-used, remove bellows adhesive from inside diameter of bellows with lacquer thinner.
3. Inspect bellows carefully for cracks, cuts, punctures and flexibility. If bellows serviceability is doubtful, replace bellows.
4. Clean bellows mounting flanges of bell housing with wire brush or sandpaper, then wipe with lacquer thinner.
5. Check shift cable for cuts or damage caused by cable which is pinched or bent too short.
6. Inspect water hose for cracks, cuts, punctures, worn spots from rubbing and flexibility.
7. Check shift shaft and shift shaft bushings for wear.
8. If shift lever roller is worn, replace shift lever assembly.
9. If heat was used to remove shift lever screw, check washer under lever for damage.

INSTALLATION

1. Install shift bushing flush with bottom of housing. (Figure 16)
2. Install shift shaft oil seal with lip facing down. (Figure 16)
3. Install new rubber bumper (if removed), using Loctite "A" on threads of stud. (Figure 15)
4. Apply Perfect Seal to threads of shift cable retainer nut and install shift cable to bell housing. (Figure 15)
5. Install water hose to bell housing with clamp positioned as shown in Figure 17.

CAUTION: Before installing universal joint bellows, clean outside diameter of bellows mounting flanges and inside diameter of bellows, as illustrated in "Cleaning and Inspection".

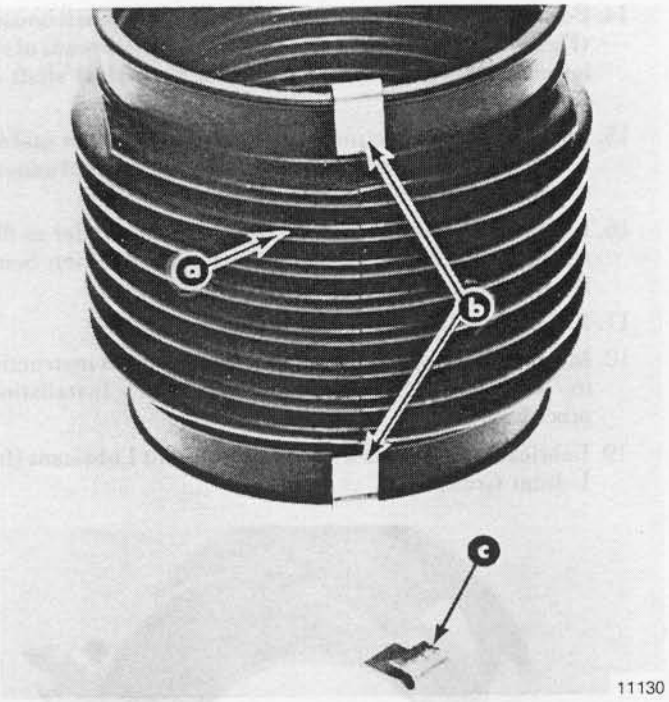


a - Hose Clamp Position

Figure 17. Approximate Hose Clamp Position on Bell Housing

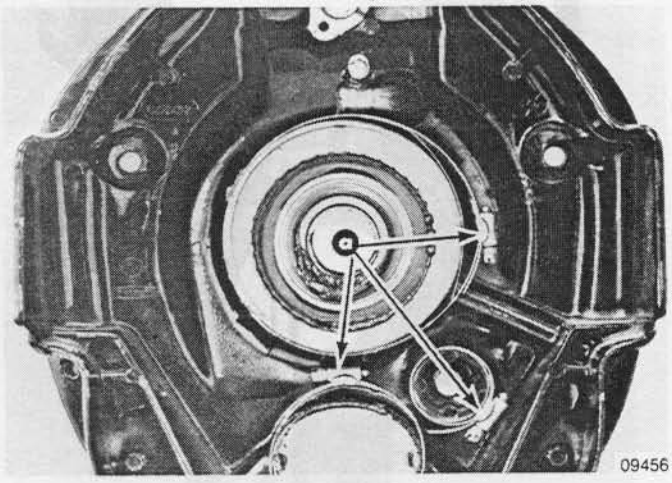
SAFETY WARNING: Extremely flammable! Vapors from Bellows Adhesive may cause flash fire or ignite explosively. Prevent buildup of vapors. Open all windows and doors. Use only in cross-ventilation. Keep away from heat, sparks and open flame. DO NOT SMOKE. Extinguish all flames and pilot lights and turn off stoves, heater, electric motors and all other sources of ignition during use and until all vapors are gone. Close container after each use. Contains Toluol and petroleum distillates. Harmful or fatal if swallowed. Avoid prolonged contact with skin or breathing of vapors. If swallowed, do not induce vomiting. Call physician immediately. Keep out-of-reach of children.

6. Apply Bellows Adhesive to inside diameter of each end of universal joint bellows. Allow adhesive to dry approximately 10 minutes or until no longer tacky.
7. Position ground clip (end with holes toward inside of bellows, Figure 18) and clamp (shown in Figure 17) over end of universal joint bellows marked "Aft-Top". Install bellows to bell housing and torque clamp to 35-38 in. lbs. (40 44kg-cm).



a - Bellows b - Ground Clips c - Hole Side

Figure 18. Grounding Clip Installation



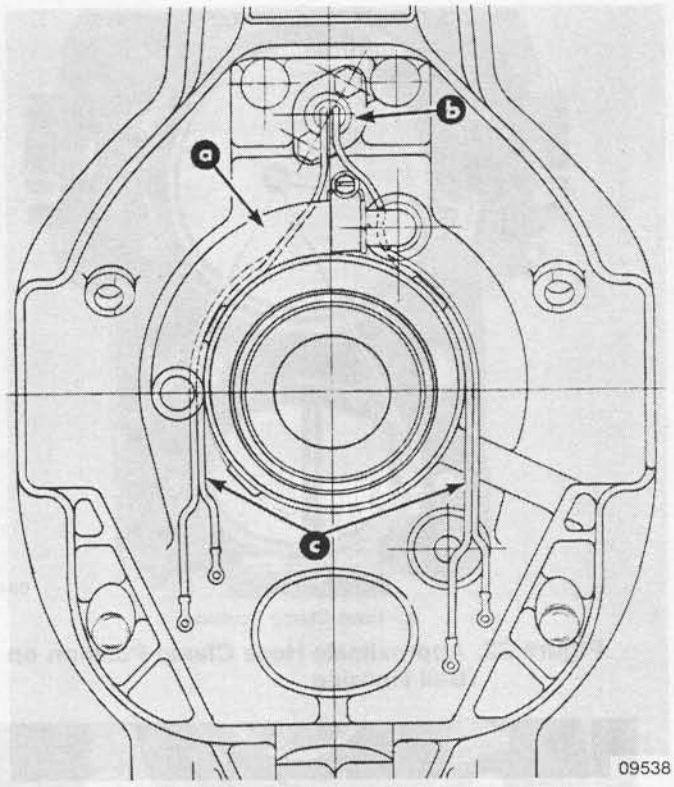
a - Hose Clamp Position

Figure 19. Approximate Hose Clamp Position on Gimbal Housing

8. If installing new bellows, then install shift bellows and exhaust bellows or tube (and ground clips) to gimbal housing with clamps positioned as shown in Figure 19. Torque clamps to 35-38 in. lbs.

   NOTE: Be sure to position grounding clips to exhaust bellows or tube before installing clamp over end of bellows. (Figure 18)

9. Insert shift cable metal end thru shift cable bellows. Multipurpose Lubricant may be used to ease installation.
10. Position water hose tube (attached to water hose) thru gimbal housing with tube end facing upward and slightly tilted to port (left) side for 8-cylinder engine. Face tube end toward starboard (right) side, slightly tilted up from a horizontal position for in-line engine.



a - Water Hose b - Retainer Cover c - Wires

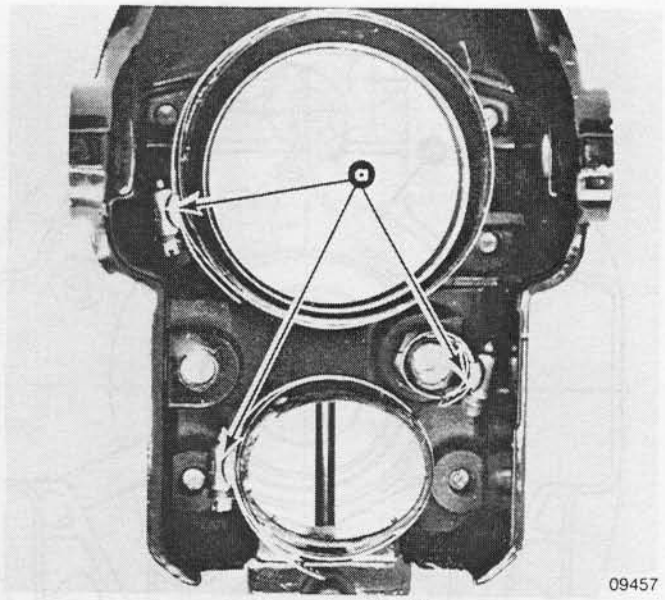
Figure 20. Correct Routing of Switch and Sender Wires

a - Hinge Pin b - Hinge Pin Tool (C-91-78310)

Figure 21. Installing Hinge Pins

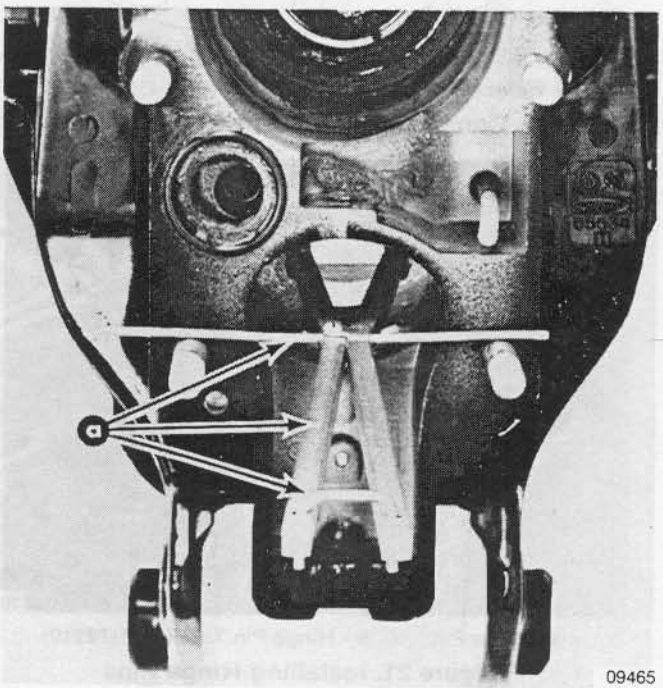
IMPORTANT: Trim position sender and limit switch wires MUST BE positioned as shown in Figure 20.

11. Apply Locquic Primer and Loctite No. 35 to threads of bell housing. Use Hinge Pin Tool (C-91-78310) to install and torque to 60 ft. lbs. (8.3mkg). (Figure 21)
12. Position clamp on front end of universal joint bellows, as shown in Figure 19. Also be sure that ground clip is in position, then install universal joint bellows to gimbal housing and torque clamp to 35-38 in. lbs.
13. If equipped with exhaust bellows, use Expander Tool (C-91-45497A1) (Figure 23) and install exhaust bellows to bell housing. Be sure that grounding clip is in place and that clamp is positioned as shown in Figure 22. Torque clamp to 35-38 in. lbs.



a - Hose Clamp Position

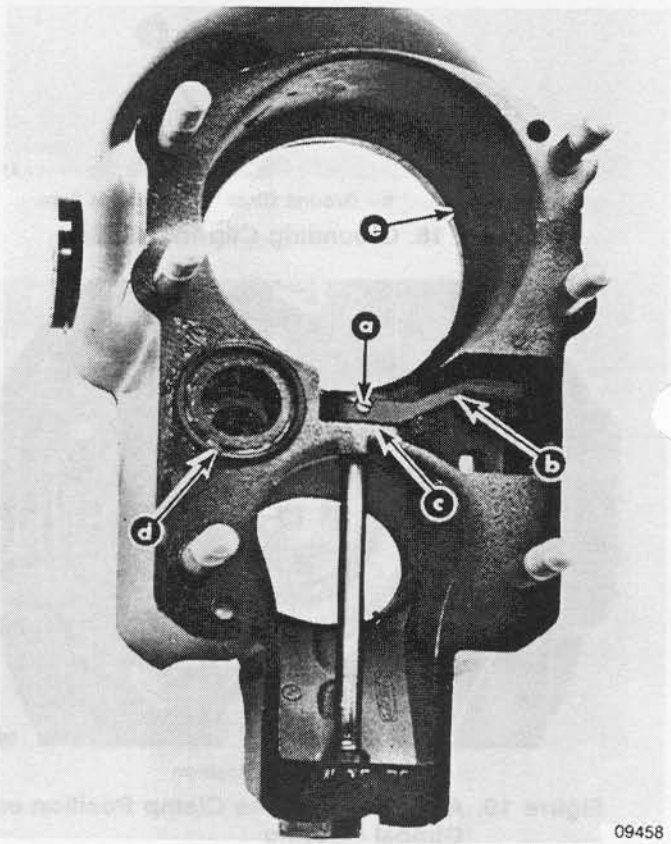
Figure 22. Approximate Hose Clamp Position on Bell Housing



a - Expander Tool (C-91-45497A1) (3 Pieces)

Figure 23. Installing Exhaust Bellows to Bell Housing

14. Position shift shaft, washer and shift lever in bell housing. (Figure 24) Apply a drop of Loctite "A" on threads of shift lever retaining screw. Install screw thru shift shaft and into shift lever.
15. Install "O" ring around water passage and rubber gasket in universal joint passage. (Figure 24) Use a general adhesive to hold gasket and "O" ring in place.
16. Install trim limit switch and trim position sender as illustrated in "Trim Limit Switch and Trim Position Sender Replacement - Installation", preceding.
17. Install drive unit as explained in Section 3.
18. Install drive unit shift cable end according to instructions in "Drive Unit Shift Cable Replacement - Installation", preceding.
19. Lubricate hinge pins with Universal Joint Lubricant [from U-Joint Grease Kit,



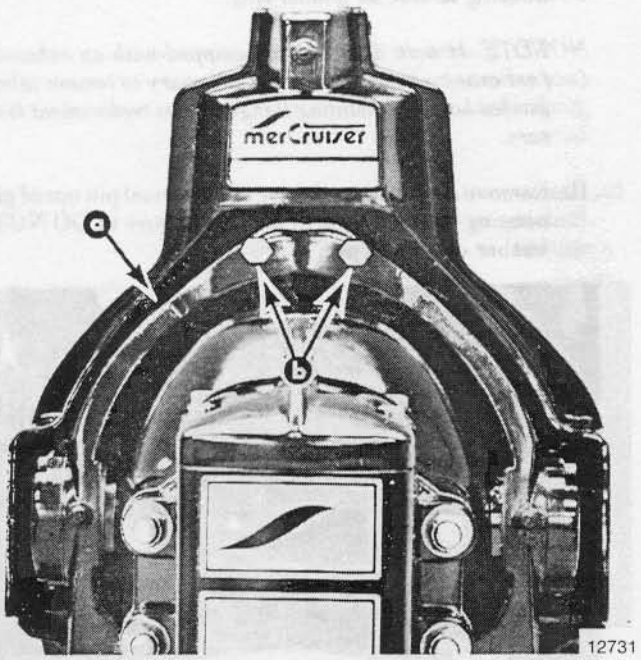
a - Screw
b - Shift Lever
c - Washer
d - "O" Ring
e - Rubber Gasket

Figure 24. Aft End of Bell Housing

Gimbal Ring Replacement

In-line MerCruiser I-Drive transom assemblies (Serial Nos. 5490562 and above) and V-8 I-Drive transom assemblies (Serial Nos. 5472161 and above) incorporate a SQUARE connection between the upper swivel shaft and gimbal ring. This design supersedes the splined connection that was used previously.

Transom assemblies with the square connection can be visually identified by 2 stainless steel bolts (located at top of gimbal ring). (Figure 1)



a - Gimbal Ring
b - Stainless Steel Bolts

Figure 1. Stainless Steel Bolts at Top of Gimbal Ring

GIMBAL RING REMOVAL (with ENGINE and TRANSOM PLATE INSTALLED)

The following gimbal ring replacement procedure DOES NOT require removal of engine and transom assembly from boat.

1. Cut out template, following.

CAUTION: Be sure to position template accurately when marking access hole locations in the following step. If holes are not located properly, it will not be possible to remove upper swivel shaft.

2. Place template on left side of gimbal housing (Figure 2) and mark gimbal housing with a punch at location indicated. Repeat same procedure on right side of gimbal housing, using opposite side of template.

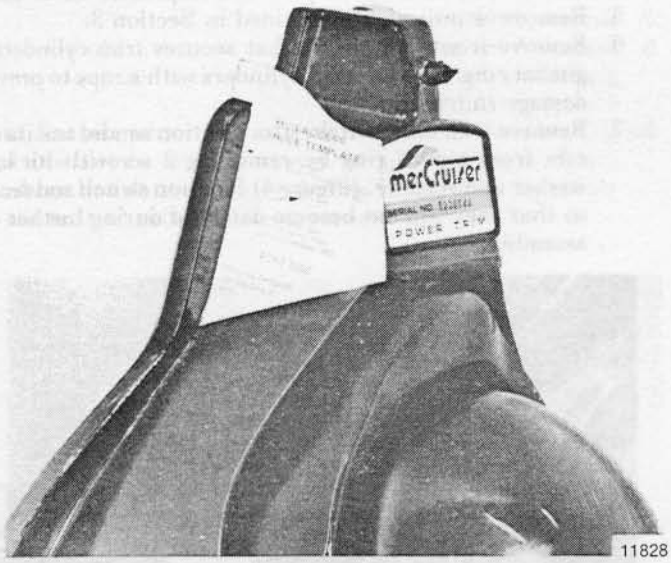
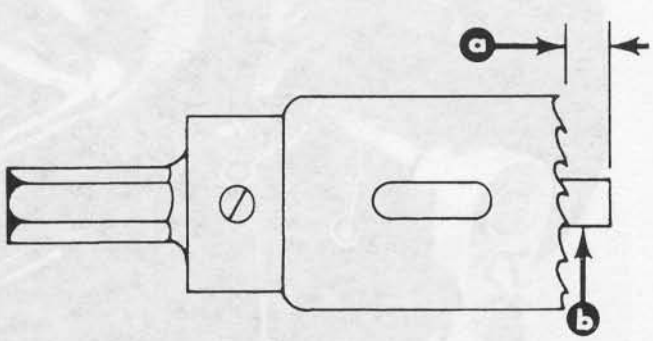


Figure 2. Template in Position on Left Side of Gimbal Housing

CAUTION: Be sure to drill and cut holes perpendicular to gimbal housing surfaces in the following steps.

3. Position drive unit so that it is straight ahead. If using hole saw from Tap and Hole Saw Kit (C-91-86191A1), drill ¼" (6.35mm) holes thru gimbal housing at locations marked with punch. If using your own saw, drill same size holes as pilot rod (in hole saw being used).

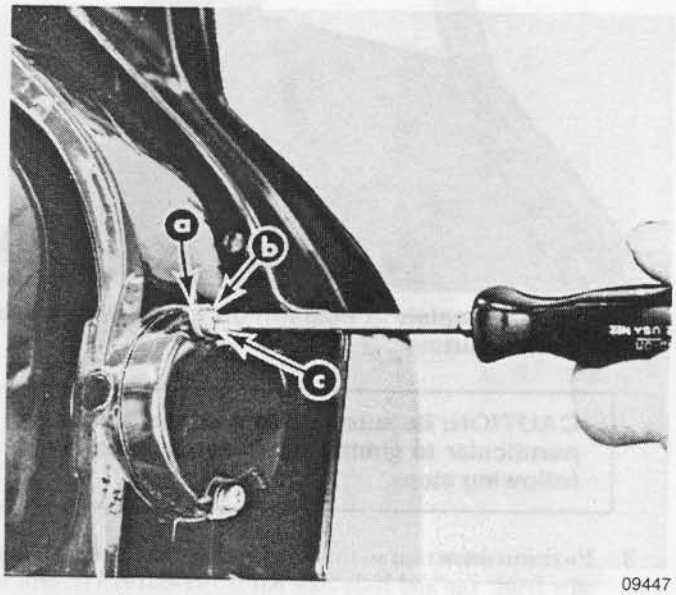
IMPORTANT: If using your own hole saw, it MUST BE fitted with a pilot rod in place of drill bit to prevent hole saw from wandering when cutting holes. Pilot rod MUST BE installed so that it protrudes a maximum of ¼" (6.35mm) from cutting teeth on hole saw. (Figure 3)



a - 1/4" (6.35mm) Maximum
b - Pilot Rod

Figure 3. Pilot Rod Installed in Hole Saw

4. Using 1⅛" (28.6mm) hole saw, cut holes thru gimbal housing at pilot hole locations. DO NOT use excessive force. Remove metal chips with compressed air or cloth.
5. Remove drive unit as explained in Section 3.
6. Remove front anchor pin that secures trim cylinders to gimbal ring. Support trim cylinders with a rope to prevent damage to trim hoses.
7. Remove trim limit switch, trim position sender and insulators from gimbal ring by removing 2 screws with lockwasher and retainer. (Figure 4) Position switch and sender so that they will not become damaged during further disassembly.

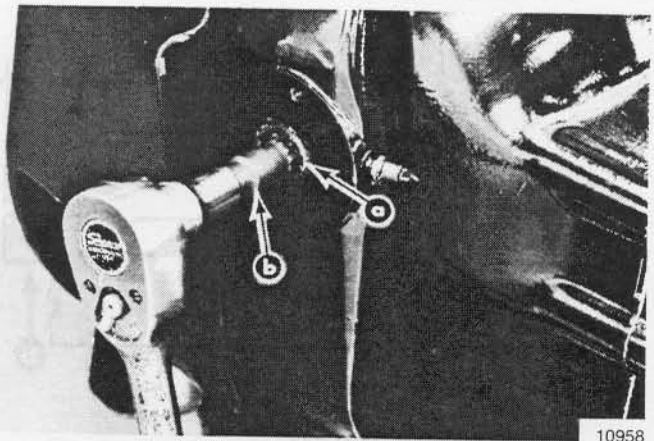


a - Retainer b - Lockwasher c - Screw

Figure 4. Trim Switch and Sender Assembly

7. Remove hinge pins from both sides of gimbal ring with Hinge Pin Tool (C-91-78310). (Figure 5)

NOTE: It may be necessary to apply heat to hinge pins to break down Loctite which was used in assembly. Use care when applying heat so that anti-galling washers (between bell housing and gimbal ring) are not damaged.



a - Hinge Pin b - Hinge Pin Tool (C-91-78310)

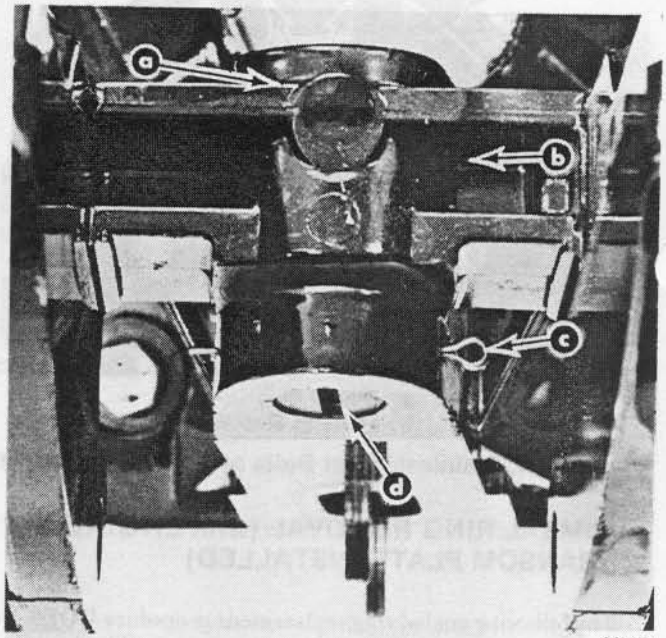
Figure 5. Removing Hinge Pins

CAUTION: Use extreme care when cutting off bellows (in next step) to prevent damage to shift cable bellows, shift cable, water pickup hose and trim leads.

8. Pull bell housing away from gimbal housing and cut off universal joint bellows. If stern drive unit also is equipped with exhaust bellows (not exhaust tube), then also cut off this bellows.
9. Loosen clamps and remove ends of bellows from mounting flange on gimbal housing and bell housing. Position bell housing to side of gimbal ring.

NOTE: If stern drive unit is equipped with an exhaust tube (not exhaust bellows), it is not necessary to remove tube from gimbal housing mounting flange, unless replacement is necessary.

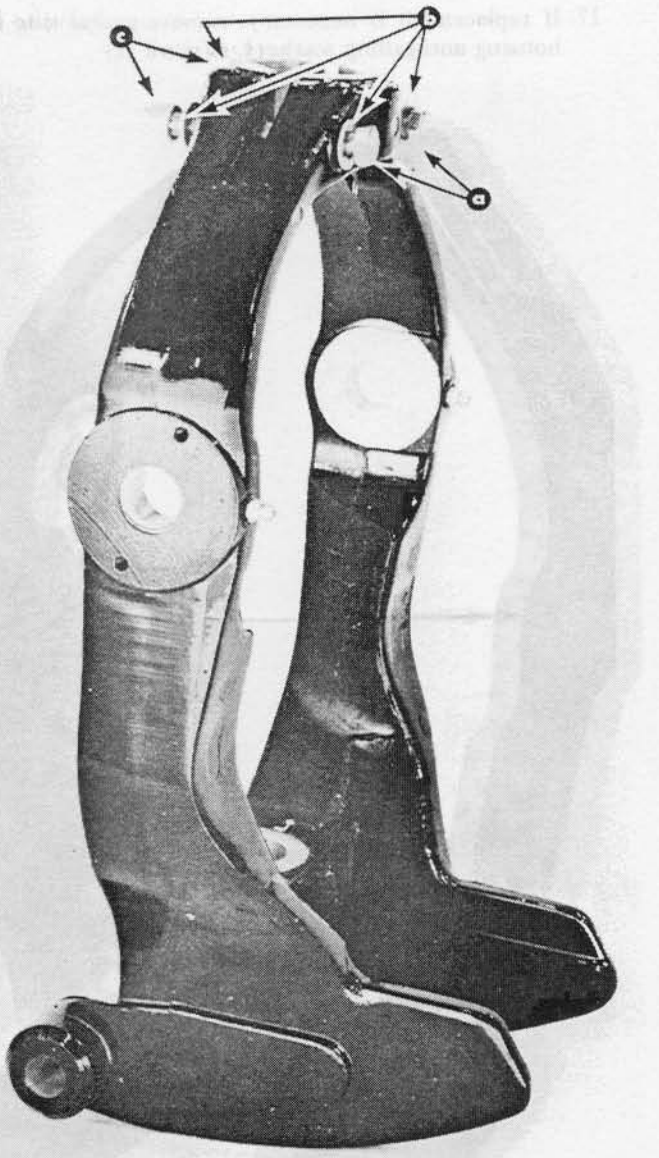
10. Remove cotter pin and drive lower swivel pin out of gimbal housing with a long drift or rod. (Figure 6) DO NOT lose washer on swivel pin.



a - Washer c - Cotter Pin
b - Gimbal Ring d - Lower Swivel Pin

Figure 6. Lower Gimbal Ring

11. Perform step "a" or "b", following:
    a. On transom assemblies with square upper swivel shaft, loosen gimbal ring screws while holding nuts on front end of gimbal ring. (Figure 7)
    b. On transom assemblies with splined upper swivel shaft, remove allen head pipe plug from bottom end of upper swivel shaft. (Figure 8)
12. Turn steering wheel, as required, so that head on steering lever retaining screw is accessible thru one of the access holes (cut in Step 4). While holding nut on other end of



a - Screws b - Flat Washers c - Nuts

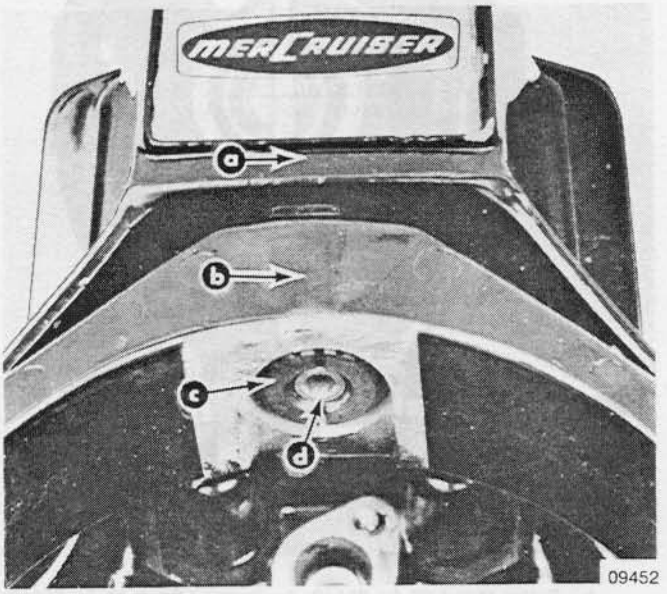
Figure 7. Gimbal Ring Screws

steering lever retaining screw with a box wrench, loosen screw with a socket and remove screw and nut thru access holes. (Discard nut; retain screw.)

13. Turn steering wheel so that steering lever is straight ahead, then unthread large nut (on top of steering lever) from upper swivel shaft by turning nut counterclockwise with a center punch and a hammer thru access holes. (Figure 9) To allow nut to become completely unthreaded from shaft, it may be necessary to perform the following:

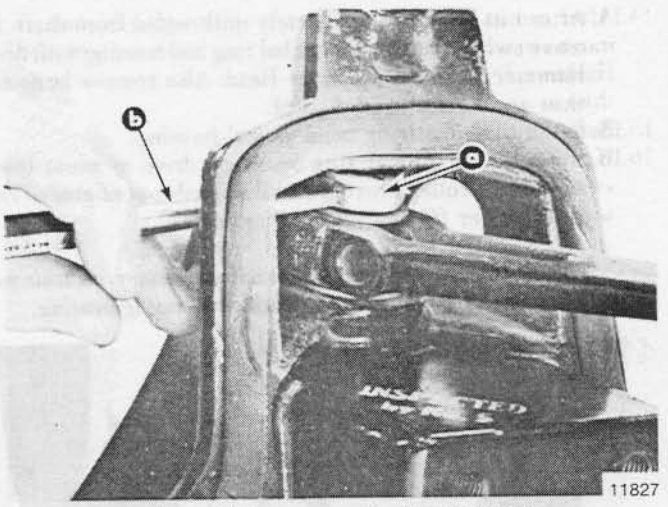
Square Upper Swivel Shaft - Remove plastic plug from bottom end of upper swivel shaft. Using Slide Hammer Puller (C-91-34569A1) and Puller Head (C-91-63616) (Figure 10), pull swivel shaft down slightly.

Splined Upper Swivel Shaft - Pull down slightly on upper swivel shaft with Slide Hammer Puller (C-91-34569A1) and Puller Head (C-91-38919). (Figure 10)



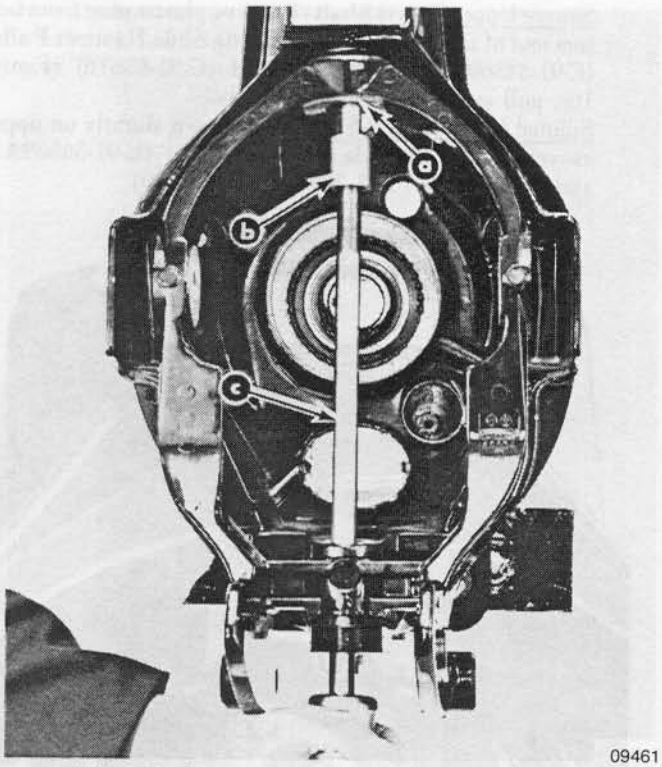
a - Gimbal Housing c - Upper Swivel Shaft
b - Gimbal Ring d - Allen Head Pipe Plug

Figure 8. Allen Head Pipe Plug



a - Large Nut b - Center Punch

Figure 9. Removing Nut on Top of Steering Lever (Viewed from Inside of Transom)

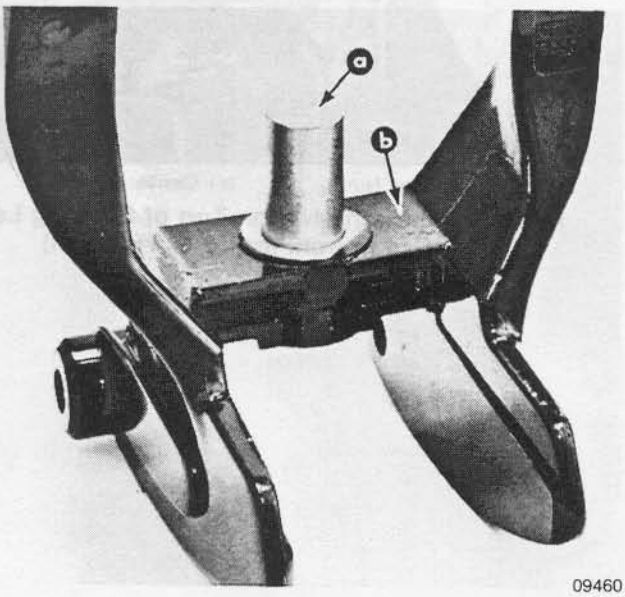


a - Swivel Shaft
b - Puller Head (C-91-38919) for Splined Shaft (C-91-63616) for Square Shaft
c - Slide Hammer Puller (C-91-34569A1)

Figure 10. Typical View - Removing Splined Upper Swivel Shaft

14. After nut has been completely unthreaded from shaft, remove swivel shaft from gimbal ring and housing with Slide Hammer Puller and Puller Head. Also remove large nut thru access hole and discard.
15. Remove gimbal ring from gimbal housing.
16. If replacing gimbal ring bearings, drive or press lower swivel pin roller bearing and 2 oil seals out of gimbal ring with Driver (C-91-33492). (Figure 11)

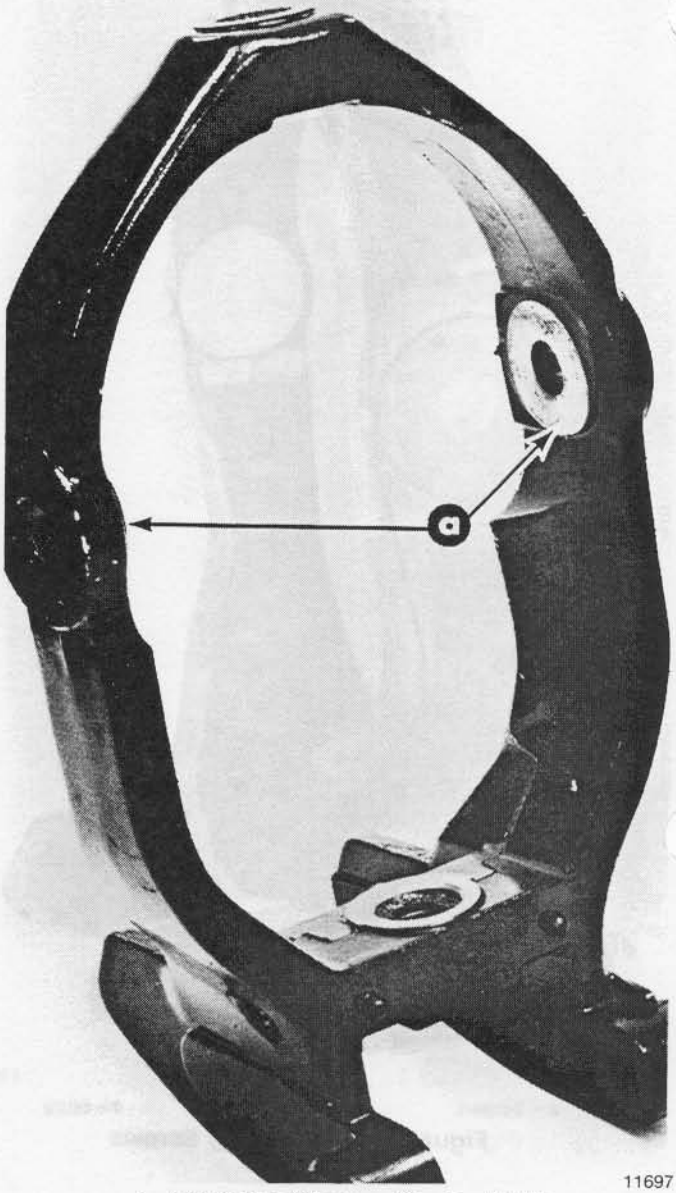
NOTE: If bearing replacement is not necessary, oil seals may be pried out of gimbal ring without removing bearing.



a - Driver (C-91-33492)
b - Gimbal Ring

Figure 11. Replacing Gimbal Ring Roller Bearing

17. If replacement is necessary, remove gimbal ring to bell housing anti-galling washers. (Figure 12)

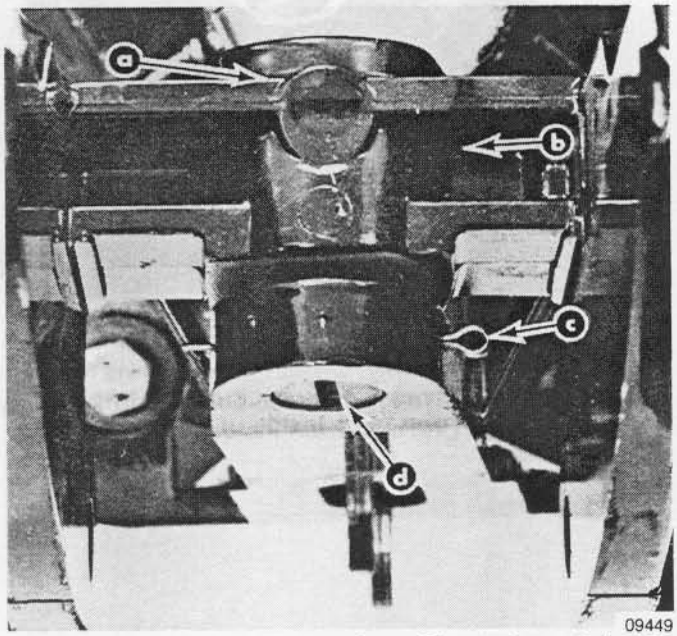


a - Anti-Galling Washers (One Each Side)

Figure 12. Replacing Anti-Galling Washers

REMOVAL with ENGINE and TRANSOM PLATE REMOVED

1. Remove transom plate assembly, as explained on Page 4-1, and place transom assembly in suitable stand.
2. Remove bell housing and exhaust bellows or tube, as explained in "Bell Housing and Bellows Replacement - Removal", preceding.
3. Remove front anchor pin that secures trim cylinder to gimbal ring. Support trim cylinders with a rope to prevent damage to trim hoses.
4. Remove cotter pin and drive lower swivel pin out of gimbal housing with a long drift or rod. (Figure 13) DO NOT lose washer on swivel pin.

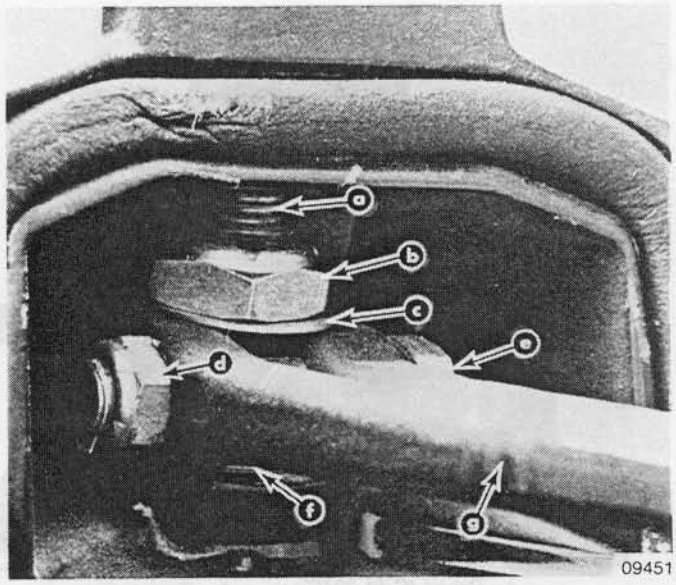


a - Washer b - Gimbal Ring c - Cotter Pin d - Lower Swivel Pin

Figure 13. Lower Gimbal Ring

5. Loosen 2 gimbal ring screws on transom assemblies with square upper swivel shaft by holding nuts on front end of gimbal ring. (Figure 7) On transom assemblies with splined upper swivel shaft, remove allen head pipe plug on bottom end of upper swivel shaft. (Figure 8)
6. Remove steering lever retaining nut and bolt. (Figure 14) Discard nut; retain screw.
7. Unthread large nut (on top of steering lever) from upper swivel shaft. To allow nut to become completely unthreaded from shaft, it may be necessary to perform the following:
   Square Upper Swivel Shaft - Remove plug from bottom end of upper swivel shaft. Using Slide Hammer Puller (C-91-34569A1) and Puller Head (C-91-63616), pull swivel shaft down slightly. (Figure 10)
   Splined Upper Swivel Shaft - Pull down slightly on upper swivel shaft with Slide Hammer Puller (C-91-34569A1) and Puller Head (C-91-38919). (Figure 10)
8. After nut has been completely unthreaded from shaft, remove swivel shaft, steering lever and washers. (Figure 14)
9. Remove gimbal ring from gimbal housing.
10. If replacing gimbal ring bearings, drive or press lower swivel pin roller bearings and 2 oil seals out of gimbal ring with Driver (C-91-33492). (Figure 11)

NOTE: If bearing replacement is not necessary, oil seals may be pried out of gimbal ring without removing bearing.



a - Upper Swivel Shaft
b - Large Nut
c - Washer
d - Nut
e - Retaining Bolt
f - Washer
g - Steering Lever

Figure 14. Upper Swivel Shaft

11. If replacement is necessary, remove gimbal ring to bell housing anti-galling washers. (Figure 12)

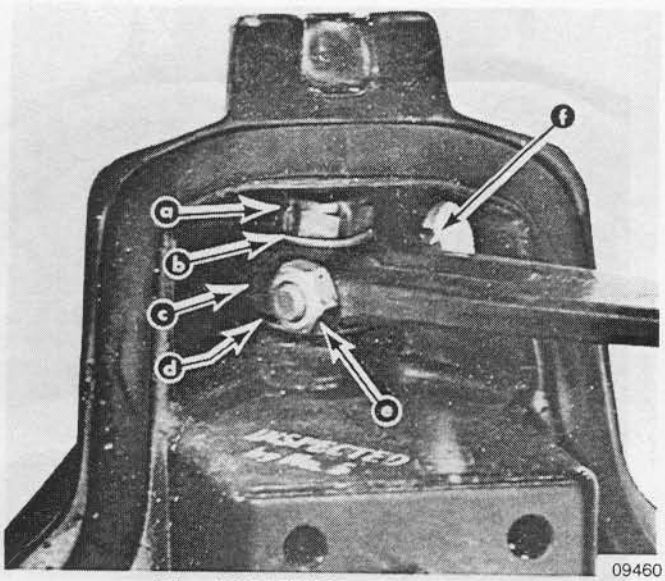
CLEANING and INSPECTION

1. Clean gimbal ring and bearings in solvent and dry with compressed air.
2. Check surface of lower swivel pin in area where needle bearing rides. Pitting, grooves and uneven wear are causes for bearing and swivel pin replacement.
3. Check gimbal ring to bell housing anti-galling washers for wear and proper alignment on gimbal ring.
4. Inspect gimbal ring support flanges for abnormal wear.
5. Inspect the following for excessive or uneven wear:
   Hinge pin bores
   Upper swivel shaft bore
   Upper swivel shaft
   Steering lever splines
6. Inspect center portion of steering lever retaining screw. If screw is grooved (from rubbing on shaft), steering lever and screw MUST BE replaced.

INSTALLATION with ENGINE and TRANSOM PLATE INSTALLED)

NOTE: New parts needed for gimbal ring installation are (1) special nut (B-11-88462) used on top end of swivel shaft and (2) plastic plugs (C-22-88847) to plug holes in gimbal housing.

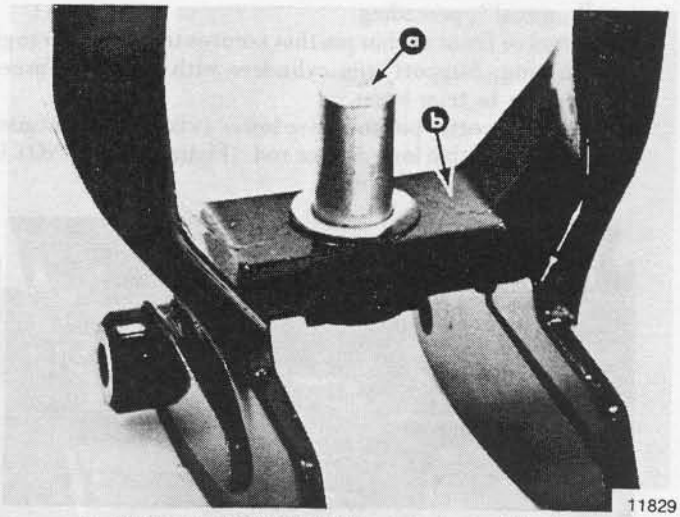
1. Install lower swivel pin roller bearing and oil seals (one on each side of bearing with lips facing up) with Driver Tool (C-91-33492). (Figure 15) Align grease hole in bearing with grease hole in gimbal ring.
2. If gimbal ring to bell housing anti-galling washers were removed, epoxy the new washers in their place, aligning hole in washer with hole in gimbal ring. (Figure 16)



a - Driver (C-91-33492) b - Gimbal Ring

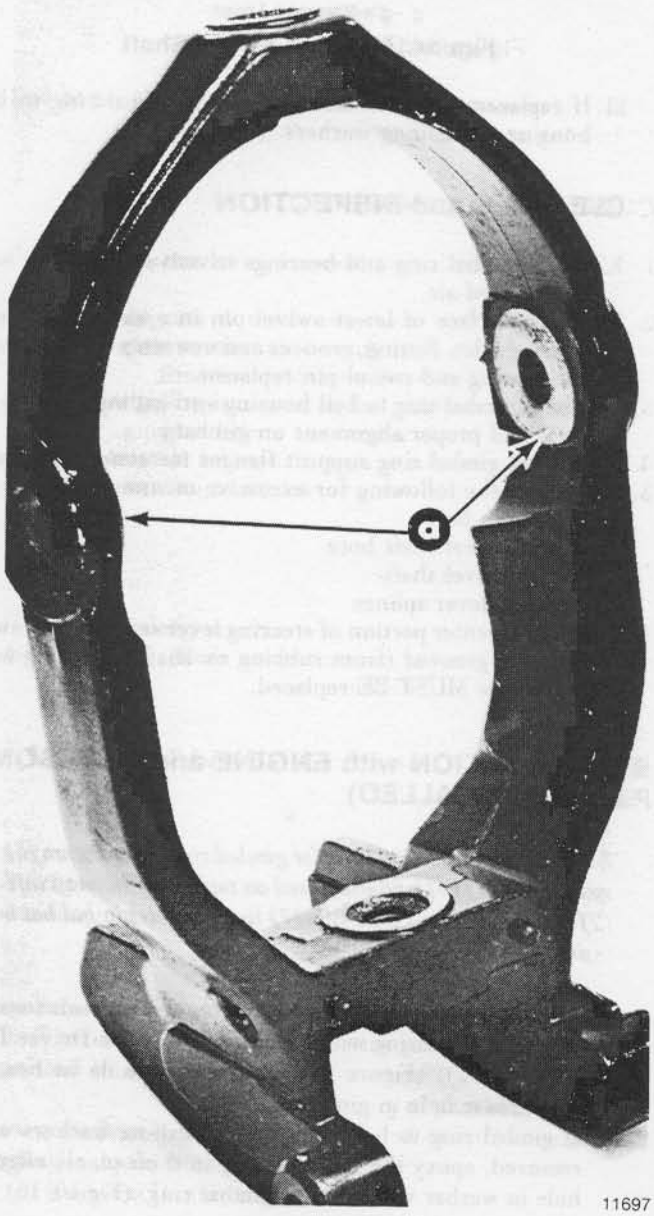
Figure 15. Installing Gimbal Ring Roller Bearing

3. Reinstall retaining screw in steering lever and thread on NEW locknut. (Figure 17) BE SURE to use new locknut. DO NOT tighten screw and nut at this time.
4. Before installing new grooved elastic locknut, thre. locknut all-the-way onto threads on new upper swivel shaft (to cut threads in elastic portion of nut), then remove nut.



a - Grooved Elastic Locknut
b - Upper Washer
c - Steering Lever
d - Lower Washer
e - Locknut
f - Retaining Screw

Figure 17. Grooved Elastic Locknut in Position (Viewed from Inside of Transom)



a - Anti-Galling Washers

Figure 16. Installing Anti-Galling Washers

5. Insert grooved elastic locknut thru one of the access holes in gimbal housing and place into position on top of steering lever and upper (smaller) washer. (Figure 17) Align locknut, upper washer, steering lever and lower washer by inserting finger into upper swivel shaft bore in gimbal housing.
6. Check that upper swivel shaft fits properly in NEW gimbal ring. Shaft MUST fit all-the-way into gimbal ring until shoulder on shaft bottoms-out. If necessary, clean up mating surfaces on gimbal ring and swivel shaft with a FINE file. After fitting swivel shaft, remove shaft and coat mating surfaces on ring and shaft with Special Lubricant 101.
7. Place one flat washer on each of the long screws and insert screws thru holes in gimbal ring (on gimbal rings with square swivel shaft bore). Place washer on each installed screw, coat threads with Special Lubricant 101 and thread on nuts. (Figure 18) DO NOT tighten nuts at this time.
8. Guide gimbal ring over bell housing and place in position in gimbal housing.

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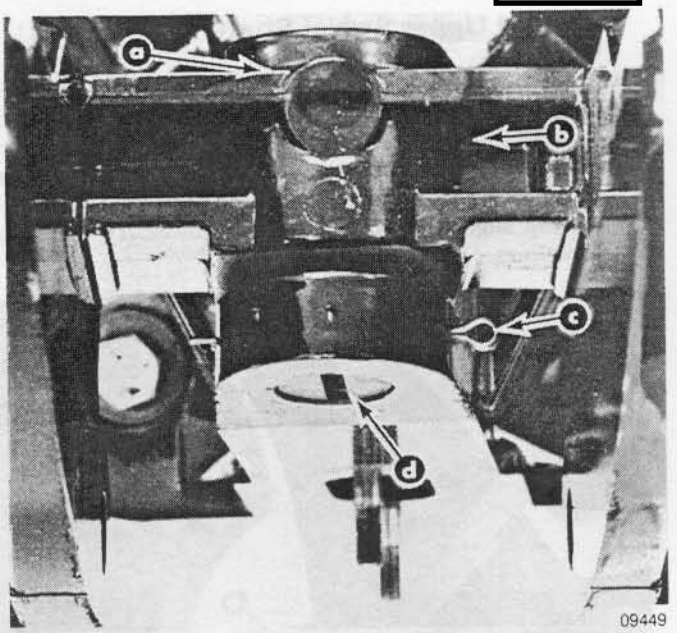
a - Screws b - Flat Washers c - Nuts

Figure 18. Gimbal Ring Screws



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a - Washer
b - Gimbal Ring
c - Cotter Pin
d - Lower Swivel Pin

Figure 19. Lower Gimbal Ring

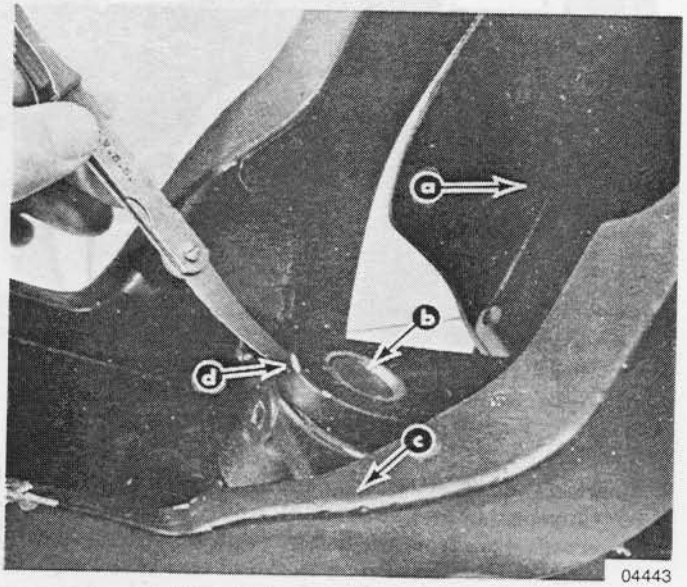
9. Lubricate lip of oil seals and bearing rollers with 2-4-C or Universal Joint Lubricant. Install washer and insert lower swivel pin from the bottom (with slotted end down). (Figure 19) Use screwdriver in slot to turn swivel pin and align cotter pin hole. Install cotter pin and bend over end. Grease swivel pin with 2-4-C Lubricant or Universal Joint Lubricant thru fitting on side of gimbal ring until lubricant appears under washer.
10. Install upper swivel shaft and locknut, as follows:

Square Upper Swivel Shaft

a. Position gimbal ring so that it is straight-ahead. While holding steering lever, washers and locknut in position with fingers (thru access holes), insert upper swivel shaft (with flat on splined portion of shaft forward) thru gimbal ring into gimbal housing. Turn gimbal ring slightly back-and-forth, if necessary, to engage splines on swivel shaft with splines in steering lever and push shaft into gimbal ring and housing as far as it will go. Thread on locknut with fingers as far as possible.
b. Tighten locknut (in clockwise direction), using grooves on nut and pin punch and hammer, until a clearance of .002" to .010" (0.051mm to 0.254mm) exists between washer (on lower pin) and gimbal housing. (Figure 20) Strike bottom end of upper swivel shaft with a brass drift and hammer to seat shaft in ring, then recheck clearance and tighten nut further, if necessary.
c. Torque gimbal ring screws to 25 ft. lbs. (3.5mkg), while holding nuts on front side of gimbal ring with wrench. (Figure 18)
d. Reinstall plug on bottom end of upper swivel shaft.

Splined Upper Swivel Shaft

a. Position gimbal ring so that it is straight-ahead. While holding steering lever, washers and locknut in position with fingers (thru access holes), insert upper swivel shaft thru gimbal ring and into gimbal housing. Thread on locknut with fingers as far as possible. Turn gimbal ring slightly back-and-forth, if necessary, to engage splines.

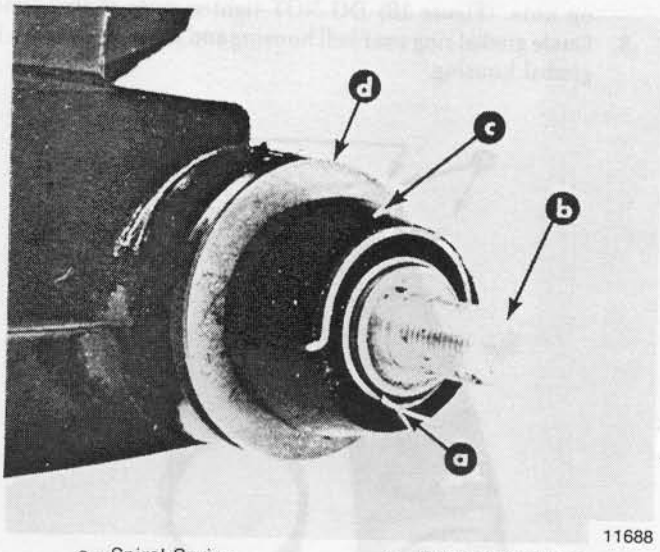


a - Gimbal Housing
b - Lower Swivel Shaft
c - Gimbal Ring
d - .002-.010" (0.051mm-0.254mm) Gap

Figure 20. Checking Gimbal Ring To Gimbal Housing Clearance

b. Tighten locknut (in clockwise direction), using grooves on nut and a pin punch and a hammer until snap ring (located in groove on swivel shaft) bottoms-out on gimbal ring. Strike bottom of upper swivel shaft with a brass drift and hammer to seat shaft.
c. Install allen head pipe plug (with Perfect Seal) in bottom of swivel shaft. Torque plug to 45-50 ft. lbs. (6.2-6.9mkg).
d. Loosen nut on top of swivel shaft to obtain .002" to .010" (0.051mm to 0.254mm) clearance between washer (on lower swivel pin) and gimbal housing. (Figure 20)

11. Turn steering wheel, as required, and torque steering lever retaining screw and nut to 60 ft. lbs. (8.3mkg), using box wrench and socket.
12. Using a ⅝"-18 tap, clean old Loctite from threaded hinge pin holes on each side of bell housing. Spray threads with Locquic Primer "T".
13. Clean bellows mounting flange(s) on gimbal housing and bell housing with sandpaper or a wire brush and wipe clean with lacquer thinner.
14. Install bell housing, universal joint bellows and exhaust bellows (if so equipped) as explained in "Bell Housing and Bellows Replacement - Installation", preceding. Grease hinge pins (thru fittings on gimbal ring) with 2-4-C Lubricant or Universal Joint Lubricant until lubricant appears on both sides of pin.
15. Reinstall trim limit switch, trim position sender and insulators on gimbal ring with 2 screws, lockwashers and retainer. DO NOT tighten screws at this time.
16. Place NEW drive shaft housing to bell housing gasket and rubber gasket into position on bell housing and reinstall drive unit.
17. Install forward end of trim cylinders to gimbal ring (Figure 21), as follows:
    a. Insert forward anchor pin in gimbal ring.
    b. Place one flat washer, one rubber bushing and one spiral spring on each side of forward anchor pin.
    c. Place cylinders in position on forward anchor pin.
    d. Place one rubber bushing, one flat washer and one nut on each end of forward anchor pin. Tighten nuts until 2 to 3 threads are exposed.
18. Adjust trim limit switch and trim position sender. (See "Index".)



a - Spiral Spring
b - Forward Anchor Pin
c - Rubber Bushing
d - Washer

Figure 21. Installing Forward Anchor Pin

SAFETY WARNING: Use extreme care when tapping holes and installing plugs (in the following steps) to ensure that it is done correctly. If holes are threaded incorrectly, or if plastic plugs are not installed properly, water leakage into boat may result.

19. Grease upper swivel shaft (thru fitting on top of gimbal housing with 2-4-C or Universal Joint Lubricant until lubricant appears under steering lever. Swivel shaft MUST BE greased heavily to prevent metal chips from getting into swivel shaft needle bearings.
20. Place drive unit in a FULL RIGHT TURN. Coat cutting portion of 1" NPT tap with grease and thread RIGHT access hole in gimbal housing, using ONLY first ½" ±1/16" (12.7mm ± 1.6mm) of tap. (Mark tap with a piece of tape to indicate depth.) BE SURE to tap hole perpendicular to housing. Place drive unit in a FULL LEFT TURN and thread LEFT access hole in same manner. Remove metal chips with compressed air or cloth.

a - Plastic Plug

Figure 22. Installing Plastic Plug

21. Clean grease from threads in gimbal housing with solvent. Coat threads of 2 plastic plugs with Perfect Seal and install in access holes (using 5/8" allen wrench) until 3/8" ± 1/16" (9.5mm ± 1.6mm) is exposed. (Figure 22) Use care to prevent cross-threading plugs.

    NOTE: (Service Tip) If a 5/8" allen wrench is not available, plugs can be installed with a bolt that has a 5/8" hex head. Thread 2 nuts onto bolt and tighten one against the other to allow bolt to be turned with a wrench or socket.

22. Touch up any scratches or bare metal spots, using a Q-tip saturated with Phantom Black Spray Paint.

SAFETY WARNING: With boat in the water and engine running, turn steering wheel thru entire steering range and check for binding. Also, check gimbal housing for leakage in area where plastic plugs were installed.

INSTALLATION (with ENGINE and TRANSOM PLATE REMOVED)

1. Install lower swivel pin roller bearing and oil seals (one on each side of bearing with lips facing up) with Driver Tool (C-91-33492). (Figure 15) Align grease hole in bearing with grease hole in gimbal ring.
2. If gimbal ring to bell housing anti-galling washers were removed, epoxy new washers in their place, aligning hole in washer with hole in gimbal ring. (Figure 16)
3. Reinstall retaining screw in steering lever and thread on NEW locknut. (Figure 17) Be sure to use new locknut. DO NOT tighten screw and nut at this time.
4. Check that upper swivel shaft fits properly into NEW gimbal ring. Shaft MUST fit all-the-way into gimbal ring until shoulder on shaft bottoms-out. If necessary, clean up mating surfaces on gimbal ring and swivel shaft with a FINE file. After fitting swivel shaft, remove shaft and coat mating surfaces on ring and shaft with Special Lubricant 101.
5. Place one flat washer on each of the long screws and insert screws thru holes in gimbal ring (with square swivel shaft bore). Place washer on each installed screw, coat threads with Special Lubricant 101 and turn on nuts. (Figure 18) DO NOT tighten nuts at this time.
6. Lubricate lip of oil seals and bearing rollers with 2-4-C or Universal Joint Lubricant. Position gimbal ring onto gimbal housing and install washer and lower swivel pin (with slotted end down). (Figure 19)
7. Use screwdriver in slot to turn swivel pin and align cotter pin hole. Install new cotter pin and bend over end. (Figure 19)
8. Install upper swivel shaft and locknut, as follows:

Square Upper Swivel Shaft

a. Insert upper swivel shaft thru gimbal ring into (but not thru) gimbal housing and continue to install swivel shaft thru lower washer, steering arm and upper washer, then install locknut on shaft. (Figure 17)
b. Tighten locknut (in clockwise direction) until a clearance of .002" to .010" (0.051mm to 0.254mm) exists between washer (on lower swivel pin) and gimbal housing. (Figure 20) Strike bottom end of upper swivel shaft with a brass drift and hammer to seat shaft in ring. Recheck clearance and tighten nut further, if necessary.
c. Torque gimbal ring screws to 25 ft. lbs. (3.5mkg) while holding nuts on front side of gimbal ring with wrench. (Figure 18)
d. Install plug on bottom end of upper swivel shaft.

Splined Upper Swivel Shaft

a. Insert upper swivel shaft thru gimbal ring into (but not thru) gimbal housing and continue to install swivel shaft thru washer and steering arm. As shaft protrudes thru steering arm, install washer and nut on shaft. (Figure 17)
b. Tighten nut on top of swivel shaft (Figure 17) until snap ring (located in groove on swivel shaft) bottoms-out on gimbal ring. Strike on bottom end of upper swivel shaft with a brass drift and hammer to seat shaft in ring.
c. Install allen head pipe plug (with Perfect Seal) in bottom of swivel shaft. Torque plug to 45 to 50 ft. lbs. (6.2-6.9mkg).
d. Loosen nut on top swivel shaft to obtain .002" to .010" (0.051mm to 0.254mm) clearance between washer (on lower swivel pin) and gimbal housing. (Figure 20)

9. Torque steering lever retaining screw and nut to 60 ft. lbs. (8.3mkg), using box wrench and socket.
10. Grease upper swivel shaft (thru fitting on top of gimbal housing) with 2-4-C or Universal Joint Lubricant until lubricant appears under steering lever.
11. Install forward end of trim cylinders to gimbal ring, as follows:
    a. Insert forward anchor pin in gimbal ring.
    b. Place one flat washer one rubber bushing and one spiral spring on each side of forward anchor pin. (Figure 21)
    c. Place cylinders in position on forward anchor pin.
    d. Place one rubber bushing, one flat washer and one nut on each end of forward anchor pin. Tighten nuts until 2 or 3 threads are exposed thru nut.
12. Touch up any scratches or bare metal spots, using a Q-tip saturated with Phantom Black Spray Paint.

13. Install bell housing and bellows, as explained in "Bell Housing and Bellows Replacement - Installation", preceding.

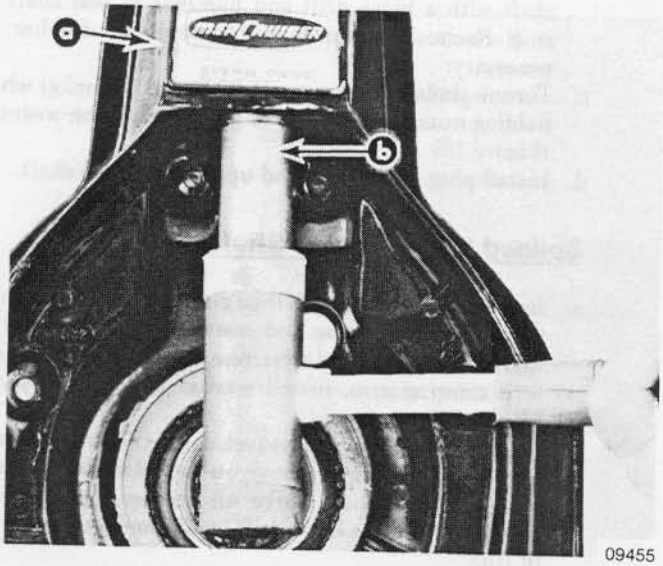
14. Install Transom Plate Assembly as outlined in "Transom Plate Installation", preceding.

SAFETY WARNING: With boat in the water and engine running, turn steering wheel thru entire steering range and check for binding. Also, check gimbal housing for leakage in area where plastic plugs were installed.

Gimbal Housing Replacement

REMOVAL and DISASSEMBLY

1. Follow complete removal procedure, as explained in "Gimbal Ring Replacement - Removal", preceding.
2. Remove cap screws, which secure exhaust elbow or separator to gimbal housing, then remove exhaust elbow or separator. See "Exhaust Elbow and Shutter Replacement - Removal", preceding.
3. If larger upper swivel shaft roller bearing requires replacement, drive bearing and seal out with Driver C-91-33491. (Figure 14)



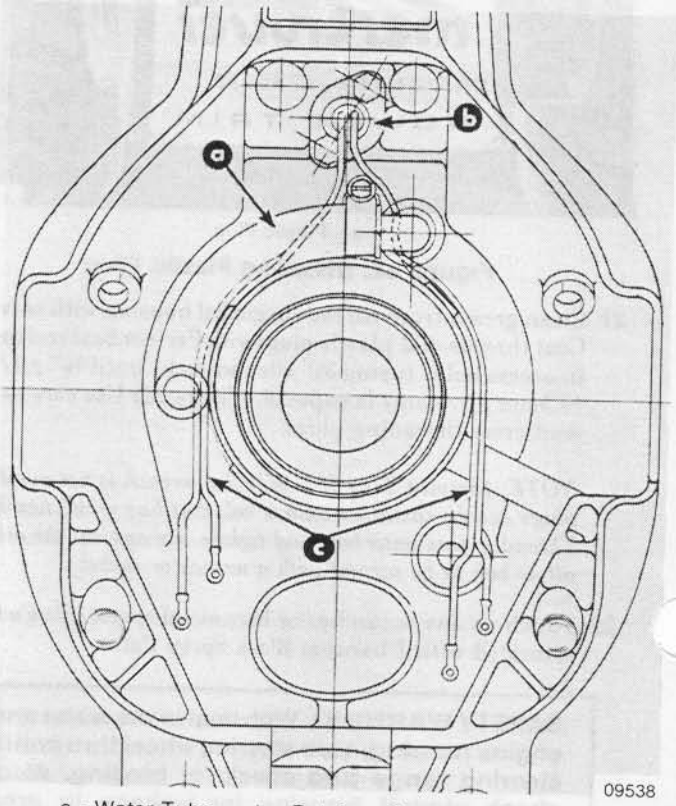
a - Gimbal Housing b - Driver (C-91-33491)

Figure 14. Removing Upper Swivel Shaft Lower Seals and Bearing

4. If smaller upper swivel shaft roller bearing needs replacement, split bearing case with chisel and pry bearing and seal out.
5. Remove retaining cover from trim limit switch and trim position sender leads, then pull leads (from inside boat) until removed from gimbal housing. (Figure 15)
6. Pull gray and black hydraulic hose from gimbal housing.
7. Remove screws, bolts and nuts, which hold inner transom plate to gimbal housing, and remove gimbal housing.

CLEANING and INSPECTION

1. Clean gimbal housing in solvent and dry with compressed air.
2. Check for corrosion damage.
3. Inspect gimbal bearing bore for signs that gimbal bearing had seized and turned in the bore.
4. Check for cracks in the lower swivel pin area.



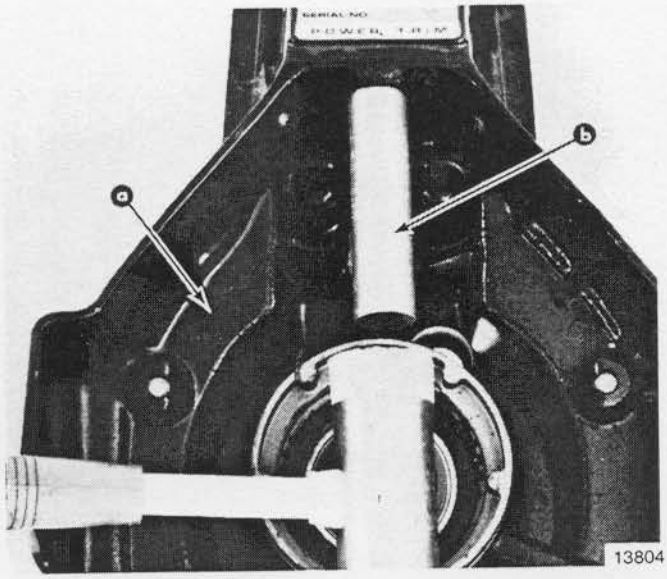
a - Water Tube b - Retainer Cover c - Wires

Figure 15. Removing Trim Limit and Trim Sender Leads

5. If any of the conditions (explained above) exist, replacement of gimbal housing is necessary.

INSTALLATION

1. Drive small roller bearing into gimbal housing with Driver (C-91-33489) until bearing bottoms out in bore. (Figure 16)
2. Install small oil seal so that face of seal is flush with housing and lip of seal faces up.
3. Install oil seal (lip facing up), larger roller bearing and second oil seal (lip facing up) with Driver (C-91-33491). (Figure 14)
4. Set gimbal housing assembly and inner transom plate in position over openings in transom, then fasten gimbal housing assembly and inner transom plate to transom, as follows:
   a. Thread 2 short cap screws with lockwashers thru 2 holes of inner transom plate into gimbal housing. (Figure 17)
   b. Insert 2 special anode head bolt assemblies with rubber seals placed between bolts and gimbal housing thru



a - Gimbal Housing b - Driver (C-91-33489)

Figure 16. Installing Small Roller Bearing in Gimbal Housing

bottom 2 holes of gimbal housing, transom and inner transom plate. (Figure 17)

c. Place flat washers on bolts and thread on 2 elastic stop nuts.

d. Place flat washers on 2 studs, which protrude thru inner transom plate, and thread on 2 elastic stop nuts.

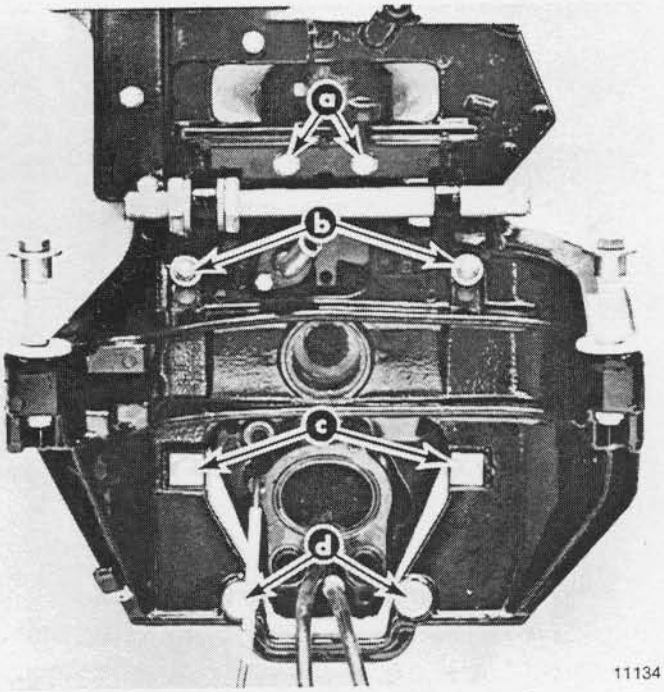
CAUTION: DO NOT attempt to drive cap screws thru transom, as threads in gimbal housing will be damaged.

e. Thread 2 long cap screws with square flat washers and lockwashers thru remaining holes in inner transom plate into gimbal housing. Square washers should be against transom plate.

5. Tighten transom plate cap screws and elastic stop nuts EVENLY (starting in the center and working out). Torque to 20-25 ft. lbs. (2.7-3.45mkg).

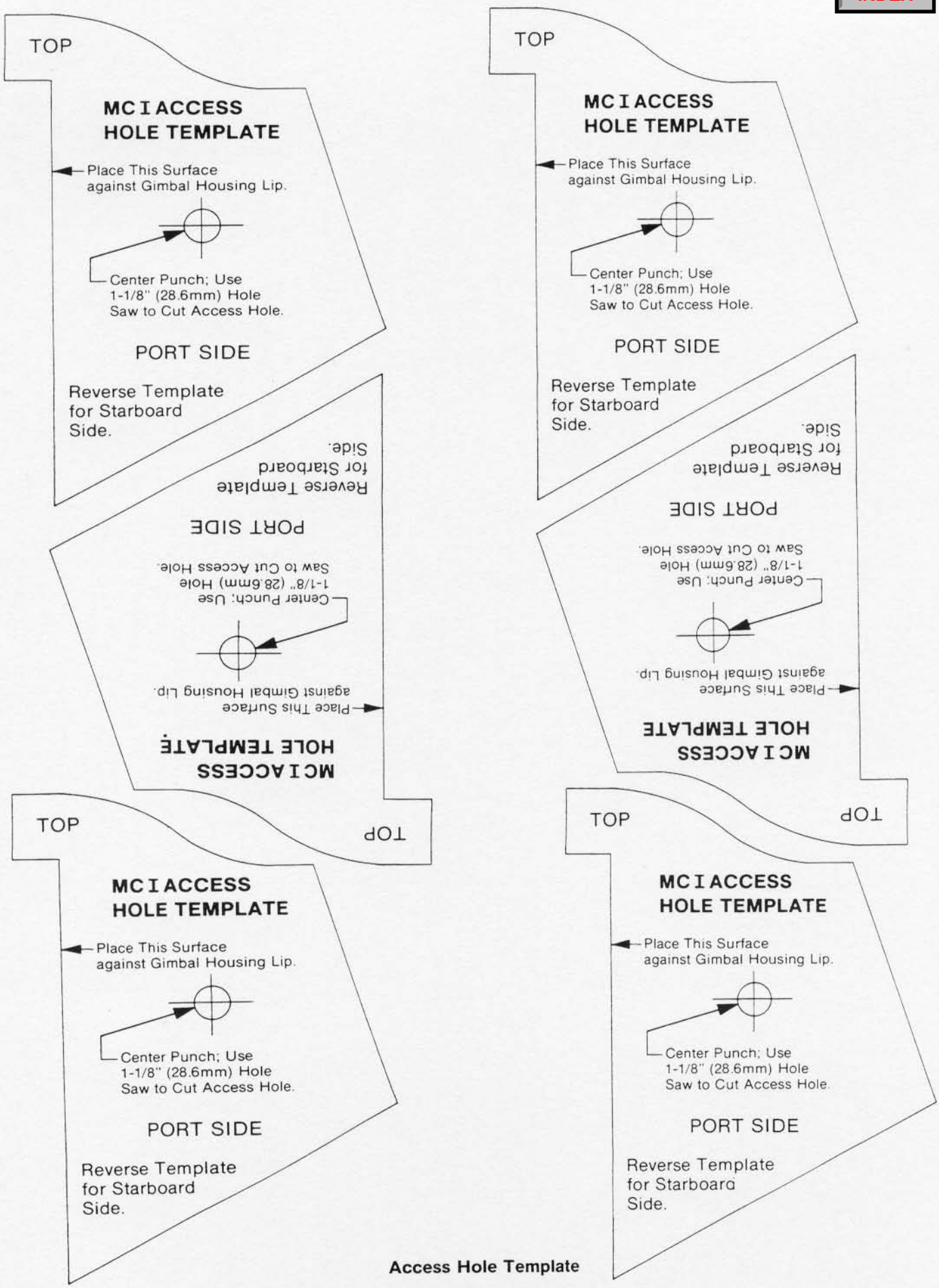
6. Install exhaust elbow or separator to gimbal housing, as explained in "Exhaust Elbow Installation", preceding.

7. Follow complete installation procedure, as explained in "Gimbal Ring Replacement - Installation", preceding.

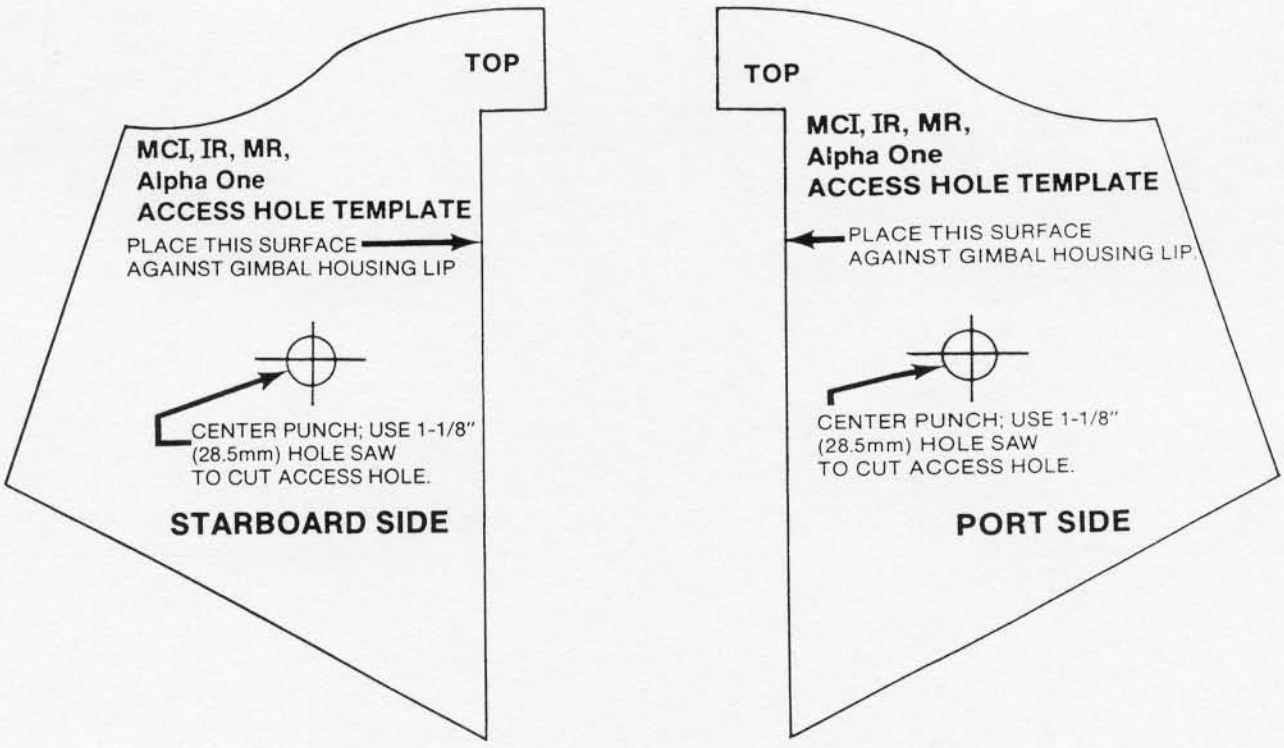


a - Short Cap Screws [2" (51mm)] and Lockwashers
b - Elastic Stop Nuts and Flat Washers
c - Longer Cap Screws [4-1/4" (10.8cm)], Lockwashers and Square Flat Washers
d - Anode Head Bolts, Flat Washers and Elastic Stop Nuts

Figure 17. Attaching Inner Transom Plate and Gimbal Housing to Transom (Typical)



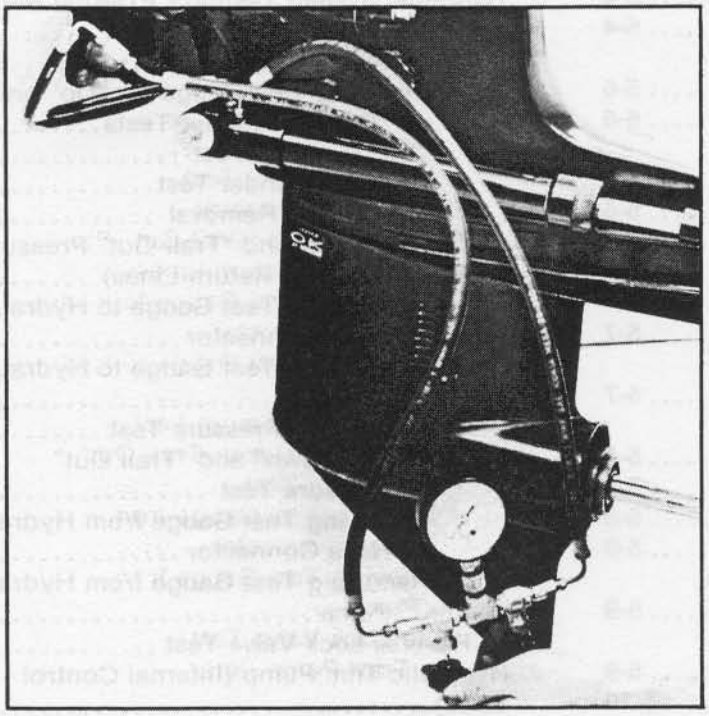
Access Hole Template



Access Hole Template

I-DRIVE

Power Trim



SECTION 5

INDEX

Page

Power Trim System Identification 5-A
Power Trim 5-1
Description 5-1
Electrical System 5-1
Single Solenoid System 5-1
Dual Solenoid System 5-2
Hydraulic System (Internal Return Lines) 5-3
Hydraulic "Up" Circuit 5-3
Hydraulic "Down" Circuit 5-3
Reverse Lock Valve 5-4
Striking Object with Light, Steady Pressure 5-4
Striking Object with Great Force 5-4
Hydraulic System Testing - Internal Return Lines (See Note Following) 5-6
Trim Cylinder Tests 5-6
Installing Test Gauge for "Up" and "Down" Cylinder Tests 5-6
"Up" Cylinder Test 5-6
"Down" Cylinder Test 5-7
Test Gauge Removal 5-7
"Up", "Down" and "Trail-Out" Pressure Tests (Internal Return Lines) 5-7
Connecting Test Gauge to Hydraulic Hose Connector 5-7
Connecting Test Gauge to Control Valve 5-8
Pump "Up" Pressure Test 5-8
Pump "Down" Pressure Test 5-8
"Trail-Out" Valve Pressure Test 5-9
Removing Test Gauge from Hydraulic Hose Connector 5-9
Removing Test Gauge from Control Valve 5-9
Reverse Lock Valve Test (All Styles) 5-10
Installing Test Gauge 5-10
Testing Reverse Lock Valve 5-10
Test Gauge Removal 5-10
Hydraulic Trim Pump (External Control Valve) 5-11
Removal and Disassembly 5-11
Electrical Testing (All Styles) 5-11
Armature Inspection and Testing 5-11
End Cap Testing 5-11
Frame and Field Testing 5-12
Solenoid Test 5-13
Reassembly (External Control Valve) 5-13
Reverse Lock Valve (All Styles) 5-18
Removal and Disassembly 5-18
Reassembly and Installation 5-19
Trim Cylinders (Internal Return Lines) 5-19

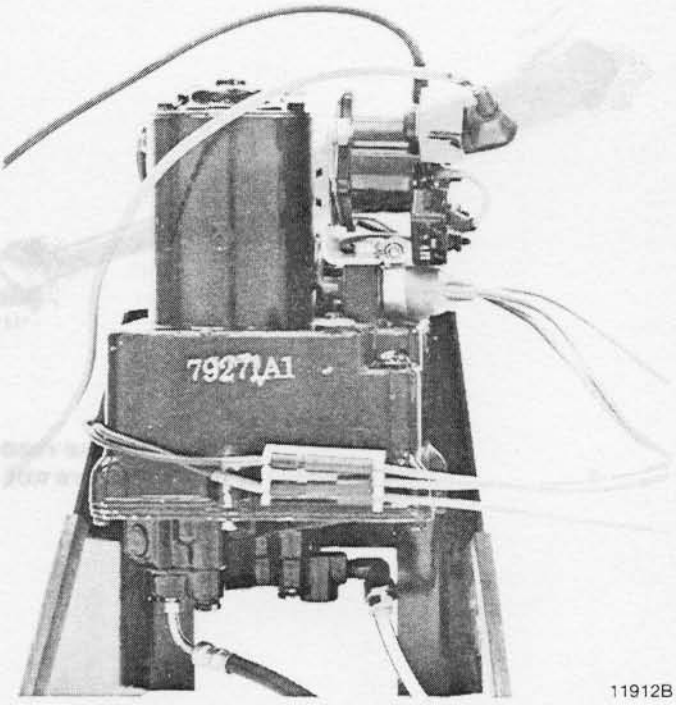
P

Removal and Disassembly 5-
Reassembly and Installation 5-21
Cylinder Reassembly 5-21
Cylinder Installation 5-21
Draining, Filling and Bleeding Trim System (All Styles) 5-22
Draining Trim System 5-22
Filling and Bleeding Trim System 5-22
Hydraulic System (External Trim Lines) 5-24
Hydraulic "Up" Circuit 5-24
Hydraulic "Down" Circuit 5-25
Hydraulic System Testing - External Return Lines (See Note Following) 5-26
Trim Cylinder Tests 5-26
Installing Test Gauge for "Up" and "Down" Cylinder Tests 5-26
"Up" Cylinder Test 5-26
"Down" Cylinder Test 5-27
Test Gauge Removal 5-27
"Up", "Down" and "Trail-Out" Pressure Tests (External Return Lines) 5-27
Connecting Test Gauge to Hydraulic Hose Connector 5-27
Connecting Test Gauge to Hydraulic Pump 5-28
Pump "Up" Pressure Test 5-
Pump "Down" and "Trail Out" Pressure Test 5-28
Removing Test Gauge from Hydraulic Hose Connector 5-29
Removing Test Gauge from Hydraulic Pump 5-29
Reverse Lock Valve Test 5-29
Hydraulic Trim Pump (Internal Control Valve) 5-30
Removal and Disassembly 5-30
Electrical Testing 5-30
Reassembly 5-31
Trim Cylinders (External Return Lines) 5-35
Removal and Disassembly 5-35
Reassembly 5-36
Dual Trim Test (All Styles) 5-37
Trailer Switch 5-37
Starboard Trim Switch 5-37
Port Trim Switch 5-37

NOTE: Before testing hydraulic system, determine what type of hydraulic pump is used. The pump pressure values are determined by the style of pump used. It is possible to have a drive unit equipped with an old style pump and new, external line trim cylinders. (see "Power Trim System Identification" following.)

POWER TRIM SYSTEM IDENTIFICATION

It is important to identify the components of the power trim system on which you will be performing service. The MerCruiser I (120 thru 260) can be equipped with three different styles of hydraulic pumps and two different styles of trim cylinders. The three styles of hydraulic pumps are: A) metal reservoir with external control valve; B) plastic reservoir with external control valve and; C) plastic reservoir with integral control valve. The two styles of trim cylinders are: D) cylinders with internal return lines and; E) cylinders with external return lines. The various styles of pumps and cylinders are shown, following.



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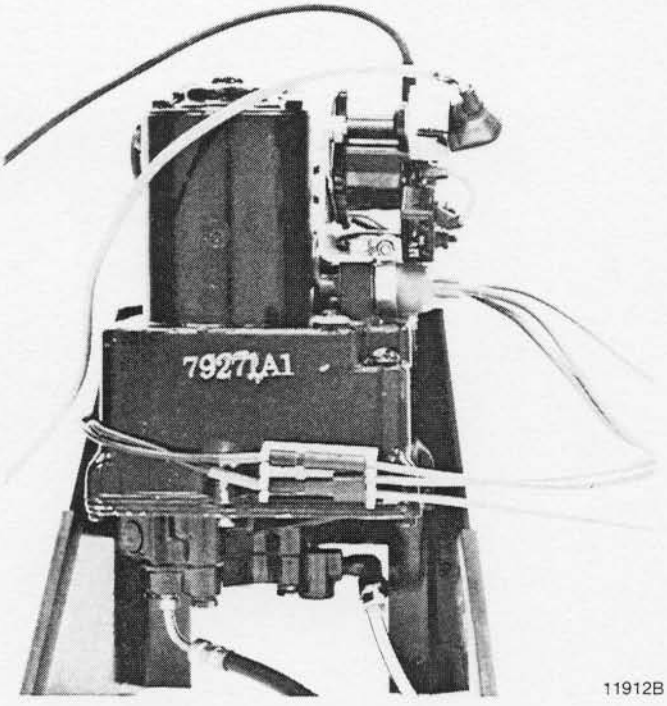
A) Hydraulic Pump



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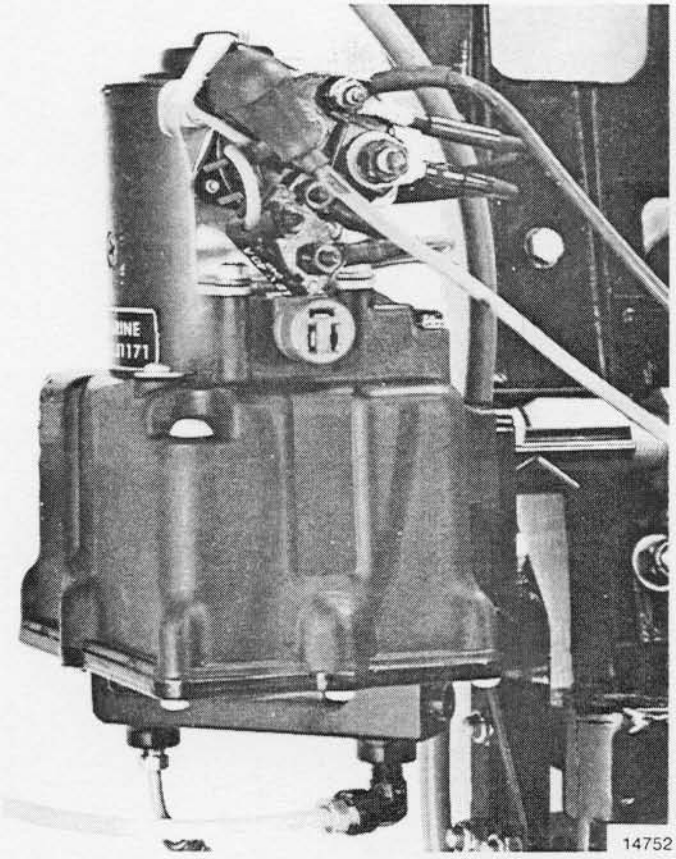
B) Hydraulic Pump



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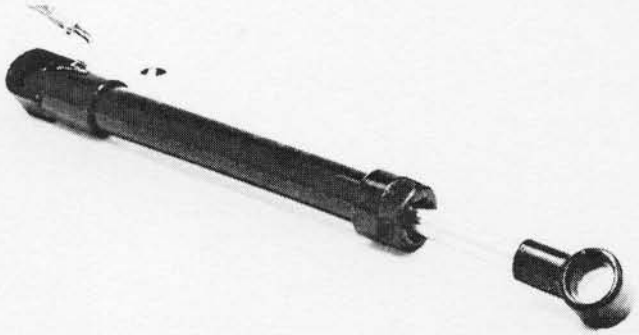
C) Hydraulic Pump



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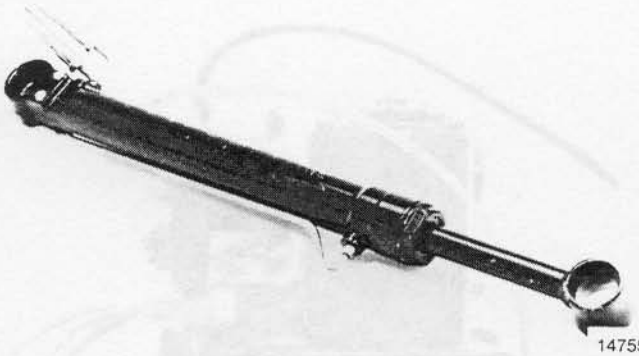
D) Trim Cylinder



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E) Trim Cylinder

Mercury Marine recommends that the different styles of trim cylinders not be mixed on one installation.

POWER TRIM
Description

MerCruiser Power Trim includes 2 systems: (1) Electrical system and (2) Hydraulic system. The electrical system (Figure 1 or 2) consists of a control, pump motor and trim limit switch, and some models are equipped with trim indicator senders. The hydraulic system (Figure 3 or 4) consists of a hydraulic pump, trim cylinder, reverse lock valve and associated hoses and fittings.

Electrical System

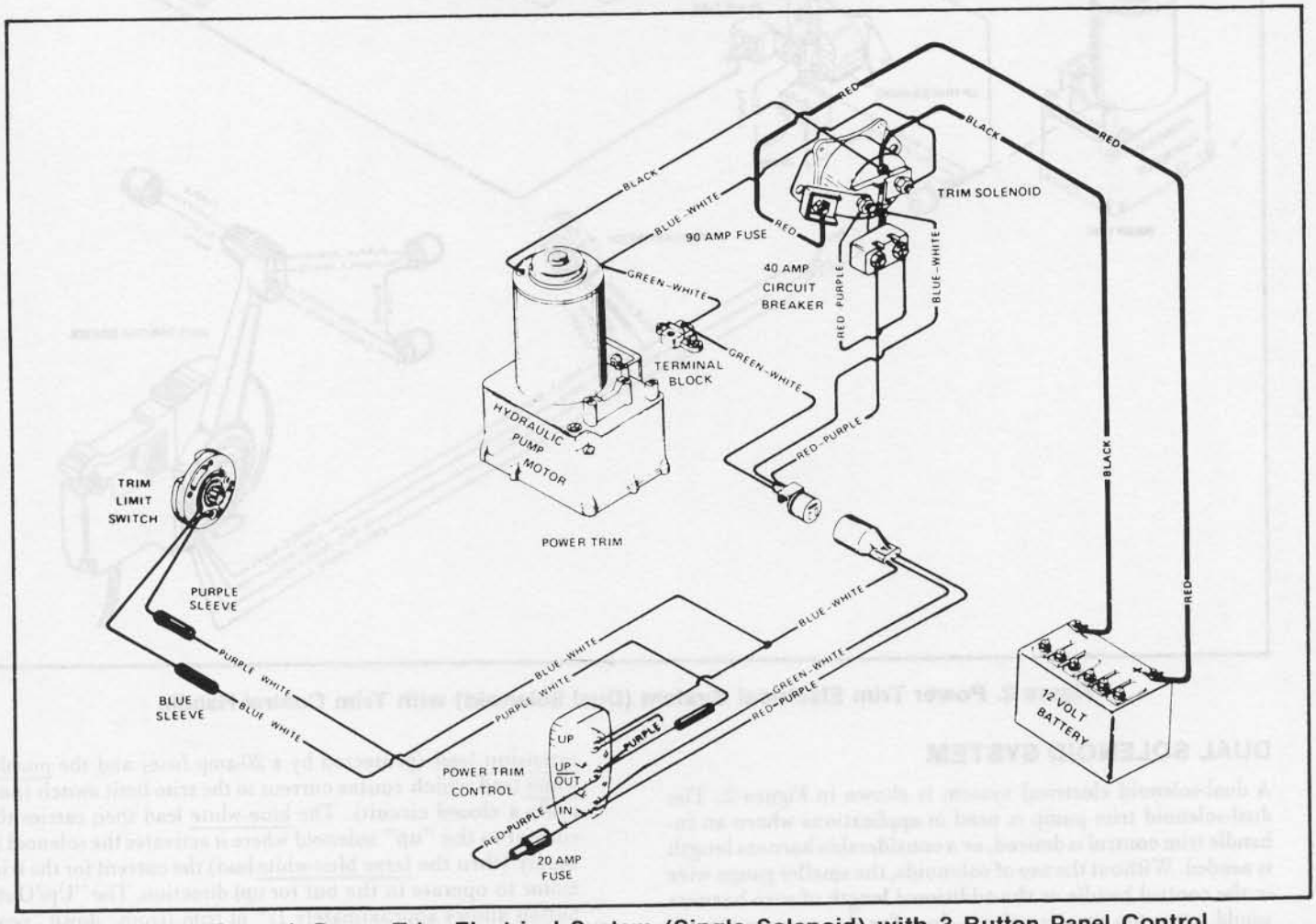


Figure 1. Power Trim Electrical System (Single Solenoid) with 3-Button Panel Control

SINGLE SOLENOID SYSTEM

A single-solenoid electrical system is shown in Figure 1. A 3-button panel control, shown in the illustration, operates the trim system. Current is supplied to control panel from battery via red lead (protected by a 90-amp fuse located on solenoid), then thru red-purple lead (protected by a 40-amp circuit breaker). When the "In" button is pressed, it routes current from the red-purple thru green-white lead, which operates the pump motor in the down direction.

When the "Up/Out" button is pressed, power from the red-purple extension lead (protected by a 20-amp fuse) flows thru the purple-white lead to the trim limit switch (normally a closed circuit). The blue-white lead then carries the current to the solenoid to supply (thru the large blue-white lead) the high-amperage current needed for the trim motor to operate in the out (or up) direction. If a solenoid were not used, the high-amperage, that is needed for trimming out against the thrust of the drive unit, would require large wires of short length (to the Power Trim controls). The "Up/Out" button allows approximately 17° of trim, after which point the trim limit switch opens, and current cannot be supplied to pump motor.

When "Up/Out" and "Up" buttons are pressed simultaneously, the trim limit switch is bypassed, and current flows from red extension wire to blue-white lead, which then proceeds to the solenoid. This allows drive unit full "up" position.

The pump motor is protected from overheating by a bi-metal switch that is built into the brush lead. If the pump motor continues to run after the cylinders are extended, the circuit is opened when the temperature of the brush lead becomes excessive (caused by high amperage draw). As the motor cools, the switch will close to permit normal operation.

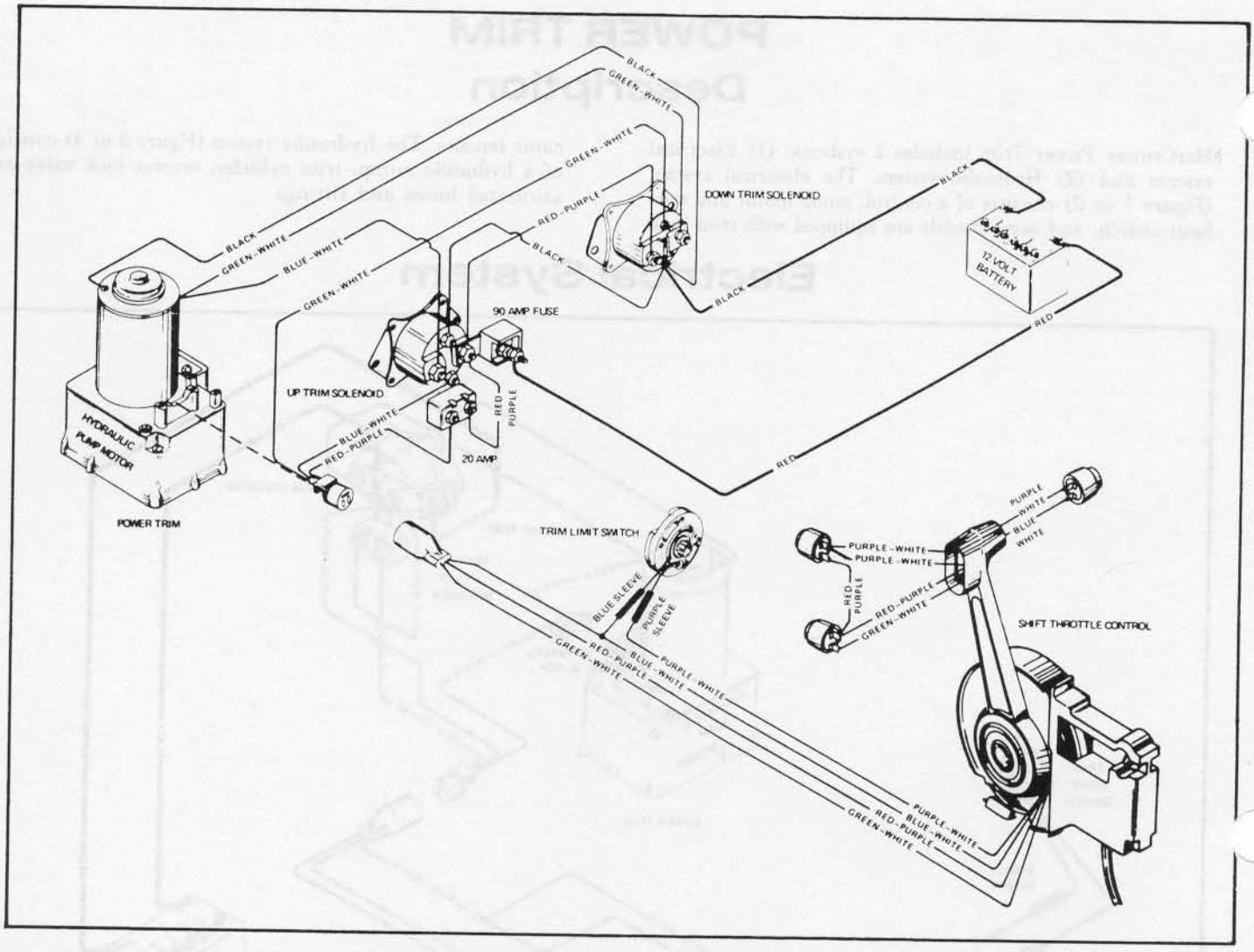


Figure 2. Power Trim Electrical System (Dual Solenoid) with Trim Control Handle

DUAL SOLENOID SYSTEM

A dual-solenoid electrical system is shown in Figure 2. The dual-solenoid trim pump is used in applications where an in-handle trim control is desired, or a considerable harness length is needed. Without the use of solenoids, the smaller gauge wire in the control handle or the additional length of wire harness would cause too great a voltage drop for the pump motor to operate properly.

Current is supplied to control panel from battery via red lead (protected by a 90-amp fuse located on solenoid) then thru red-purple lead (protected by a 20-amp circuit breaker). Pressing the "In" button connects the red-purple lead to the green-white lead which routes current to the "down" solenoid. Current from the green-white lead activates the solenoid to supply (thru the large green-white lead) the high-amperage current need for the trim motor to operate in the down direction.

Pressing the "Up/Out" button connects the red-purple extension lead (protected by a 20-amp fuse) and the purple-white lead which routes current to the trim limit switch (normally a closed circuit). The blue-white lead then carries the current to the "up" solenoid where it activates the solenoid to supply (thru the large blue-white lead) the current for the trim motor to operate in the out (or up) direction. The "Up/Out" button allows approximately 17° of trim (from "down" position) after which point the trim limit switch opens and current cannot be supplied to pump motor. Pressing the "Up/Out" and "Up" buttons simultaneously connects the purple-white extension lead to the blue-white lead which bypasses trim limit switch. Current then proceeds to the "up" solenoid and allows drive unit full "up" position.

The pump motor is protected from overheating by a bi-metal switch that is built into the brush lead. If the pump motor continues to run after the cylinders are extended, the high amperage opens the circuit when the temperature of the brush lead becomes excessive. As the motor cools, the switch will close to permit normal operation.

Hydraulic System

HYDRAULIC "UP" CIRCUIT (Figure 3)

When Power Trim pump is activated in the up direction, the gear draws fluid from check ball "1", thereby causing hydraulic pressure (indicated in dark shaded area) to open valve "2" and allow fluid to move through the valve and into trim cylinder chambers "3". Here, the pressure created pushes the piston outward. Fluid in the "down" side of system (indicated in light shaded area) is forced out of cylinder and back through reverse lock valve, then through valve "4" and into pump reservoir.

Valve "5" serves as a backup safety valve to prevent excessive pressure in the "up" circuit when valve "2" is closed (pump not running). Valve "6" regulates amount of "up" pressure produced by the pump and is forced open when, for example, the drive unit is in full "up" position, and the pump still is operating. Valve "2" prevents fluid from leaking back thru pump, thereby holding drive unit in desired raised position.

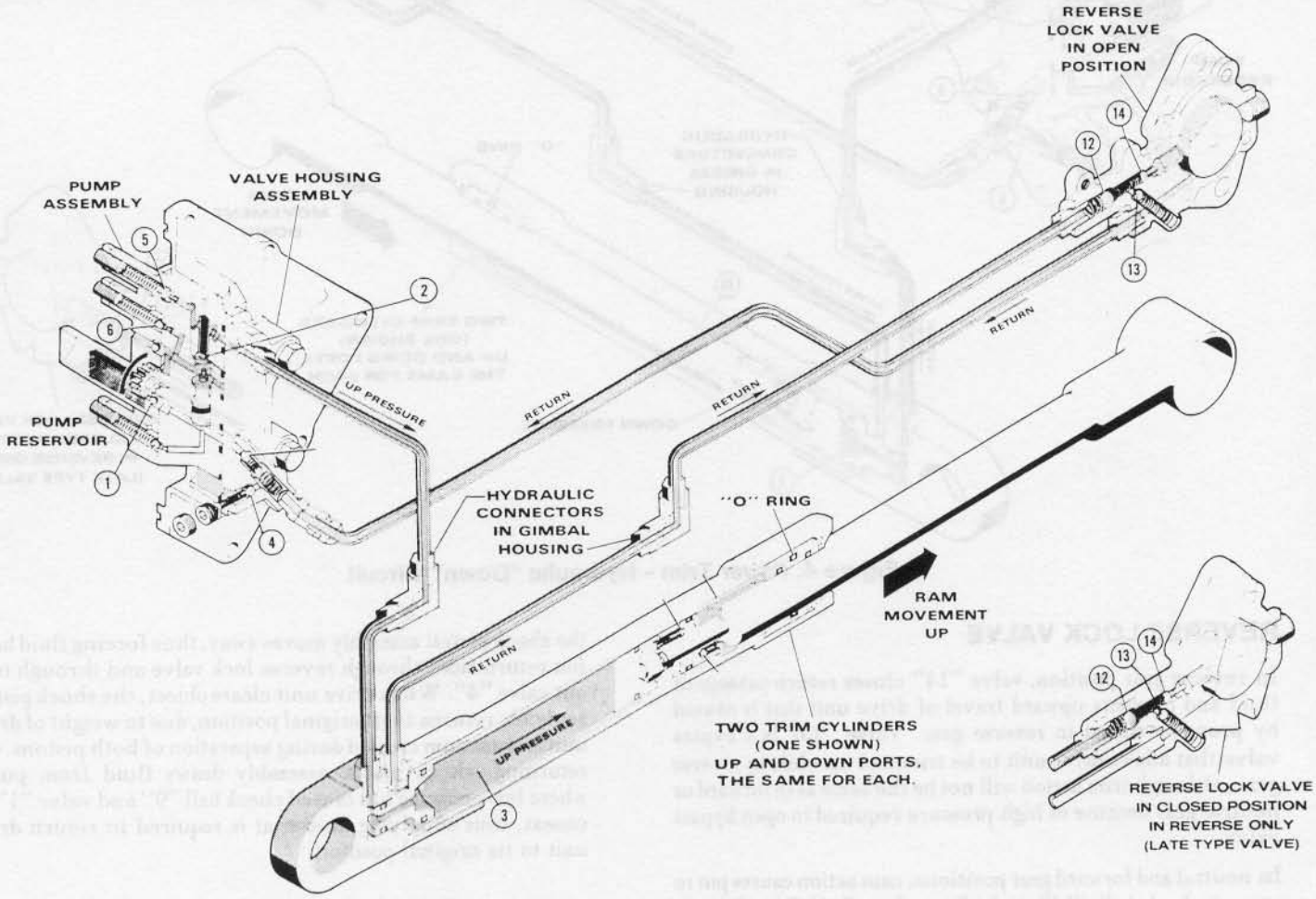


Figure 3. Power Trim - Hydraulic "Up" Circuit

HYDRAULIC "DOWN" CIRCUIT (Figure 4)

When Power Trim pump is activated in the down direction, the gear draws fluid from check ball "7", thereby causing hydraulic pressure (indicated by dark shaded area). This pressure moves slide valve "8" which unseats check ball "2" to allow fluid return. Fluid pressure then moves through "9" to reverse lock valve and on to trim cylinders. At the cylinder, fluid flows between double walls "10" and into inner cylinder on "down" side of piston, where it moves the piston inward. Fluid on "up" side of cylinder "3" is forced back to pump and thru valve "2" (held open by "8"), then into gears to supply fluid to the "down" side. Excess fluid, returning from "up" side, passes thru valve "4" or "11" to return to reservoir.

Valve "11", which regulates amount of "down" pressure produced by the pump, is forced open when, for example, the drive unit is completely down and the pump still is operating. Also, when pump operates in down direction, excess fluid (returning from "up" side) produces enough pressure to unseat valve.

Trail-out valve "4" holds drive unit in position during deceleration. Should unit strike a submerged object with light, steady pressure, the trail-out valve will unseat and permit unit to clear the object. Valve "9" closes off its return passage to permit sufficient pressure to build up in order for trail-out valve to operate.

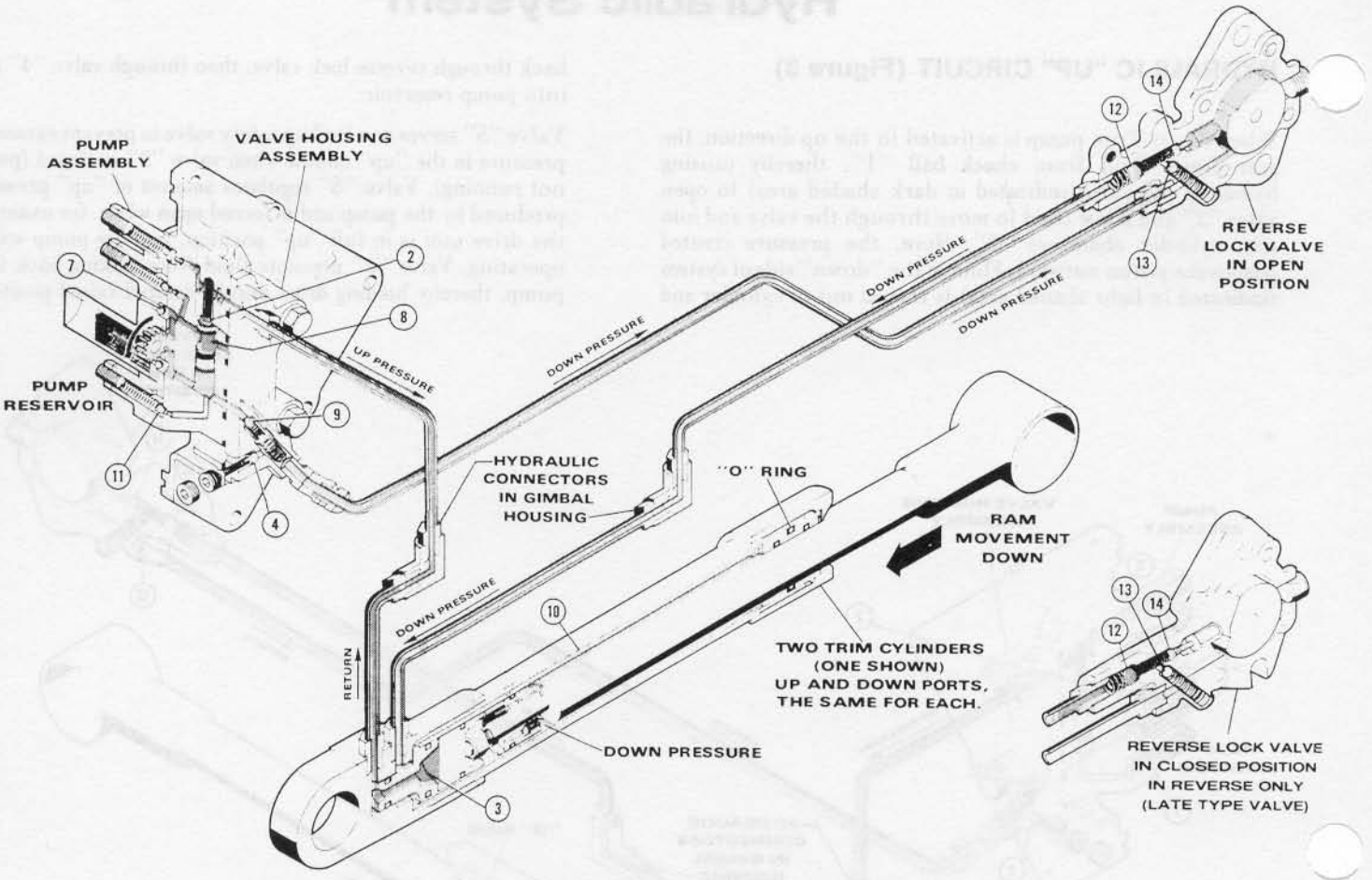


Figure 4. Power Trim - Hydraulic "Down" Circuit

REVERSE LOCK VALVE

In reverse gear position, valve "14" closes return passage of fluid and prevents upward travel of drive unit that is caused by propeller thrust in reverse gear. Valve "13" is a bypass valve that allows drive unit to be trimmed up while in reverse gear, although trim action will not be the same as in forward or neutral gear because of high pressure required to open bypass valve.

In neutral and forward gear positions, cam action causes pin to unseat check ball "14" and allows free fluid flow through reverse lock valve. However, if a submerged object is hit with great force, rapid return of fluid through reverse lock valve pushes valve "12" closed. This causes sufficient pressure to open valves in trim cylinder (procedure explained, following).

STRIKING OBJECT with LIGHT, STEADY PRESSURE (Figure 5)

When drive unit strikes a submerged object with light, steady pressure, the shock piston assembly "15" and floating piston "16" separate. The floating piston remains in position while the shock piston assembly moves away, thus forcing fluid back (on return side) through reverse lock valve and through trail-out valve "4". When drive unit clears object, the shock piston assembly returns to its original position, due to weight of drive unit and vacuum created during separation of both pistons. On returning, shock piston assembly draws fluid from pump where low pressure has caused check ball "9" and valve "1" to unseat, thus supplying fluid that is required to return drive unit to its original position.

STRIKING OBJECT with GREAT FORCE (Figure 6)

If a submerged object is hit with great force, shock piston assembly "15" and floating piston "16" separate quickly, thus causing rapid return of fluid through reverse lock valve that seats the valve "12". This allows pressure to build up in cylinders sufficient enough to open valves "17", which allows fluid to pass through shock piston and occupy "18" cavity that is created from the separation of the pistons. After object is cleared, valve "19" allows fluid to return through piston as unit comes back down to its original position.

Striking Object with Light, Steady Pressure

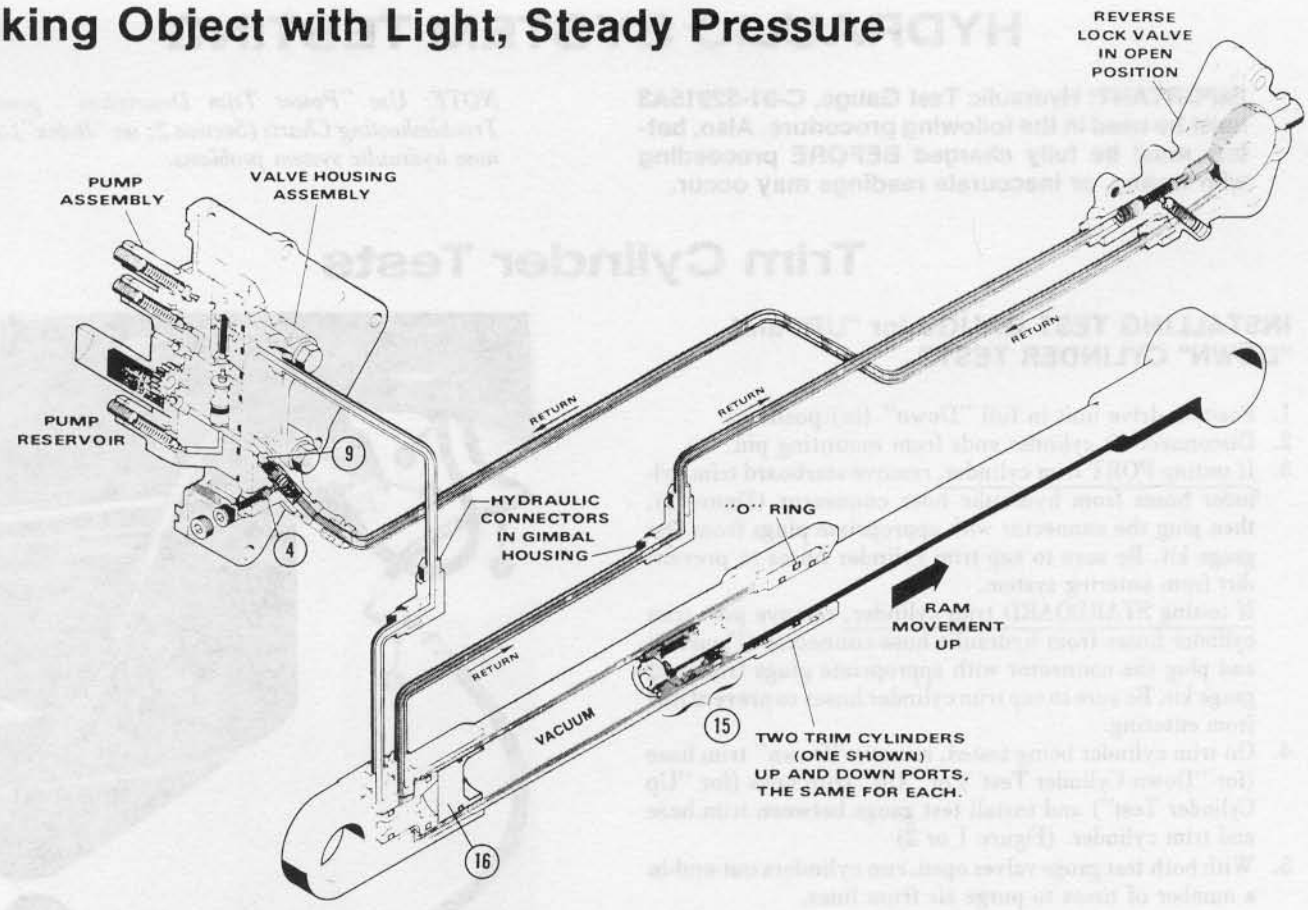


Figure 5. Striking Object with Light, Steady Pressure

Striking Object with Great Force

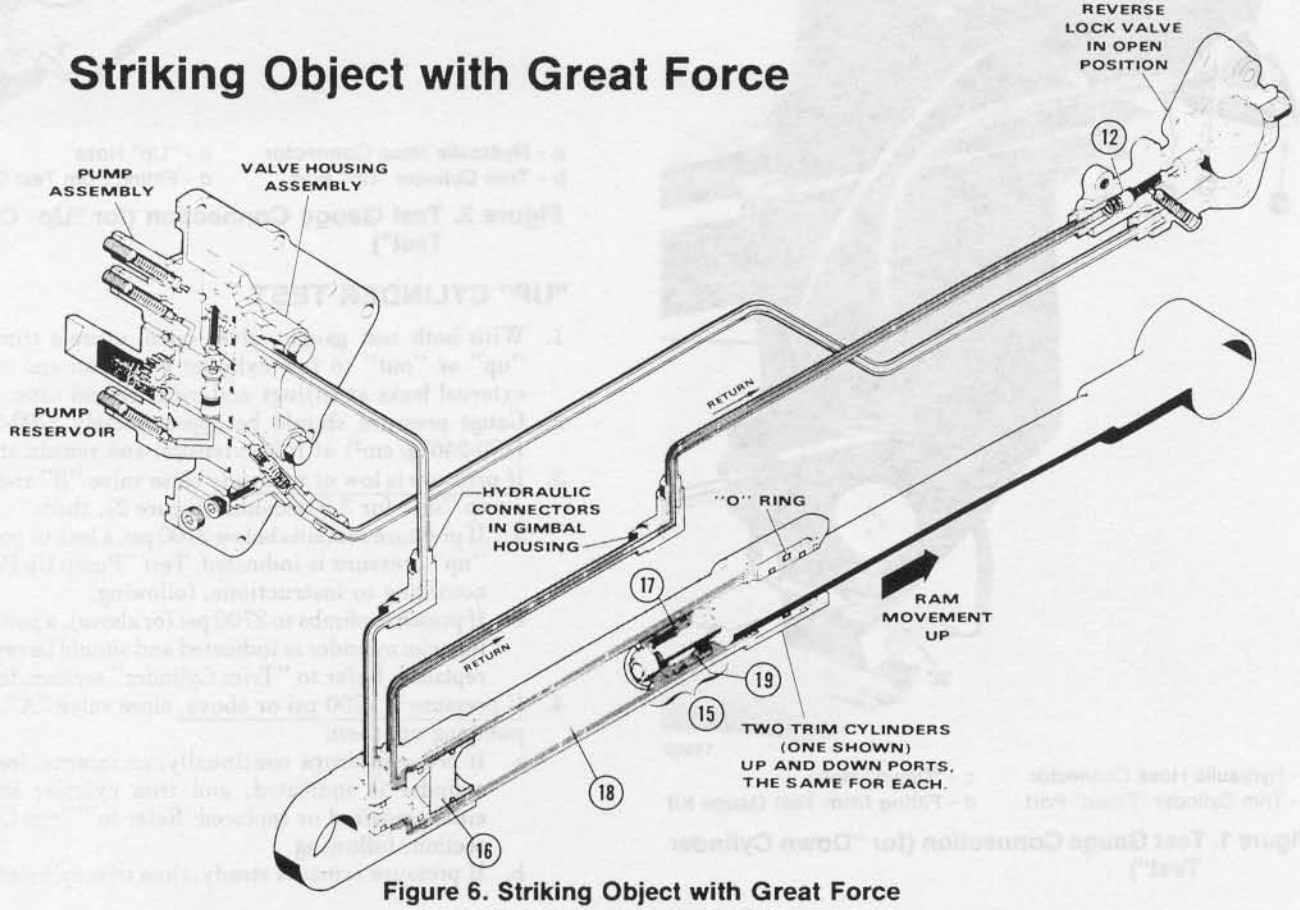


Figure 6. Striking Object with Great Force

HYDRAULIC SYSTEM TESTING

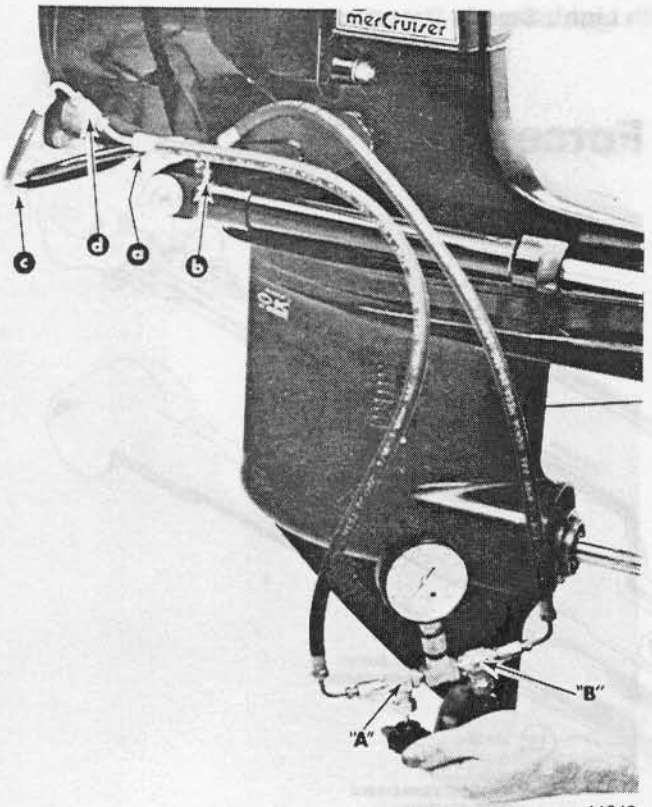
IMPORTANT: Hydraulic Test Gauge, C-91-52915A3 must be used in the following procedure. Also, battery must be fully charged BEFORE proceeding with testing, or inaccurate readings may occur.

NOTE: Use "Power Trim Description", preceding, and Troubleshooting Charts (Section 2; see "Index") to help diagnose hydraulic system problems.

Trim Cylinder Tests

INSTALLING TEST GAUGE for "UP" and "DOWN" CYLINDER TESTS

1. Position drive unit in full "Down" (in) position.
2. Disconnect aft cylinder ends from mounting pin.
3. If testing PORT trim cylinder, remove starboard trim cylinder hoses from hydraulic hose connector (Figure 1), then plug the connector with appropriate plugs from test gauge kit. Be sure to cap trim cylinder hoses to prevent dirt from entering system.
   If testing STARBOARD trim cylinder, remove port trim cylinder hoses from hydraulic hose connector (Figure 2) and plug the connector with appropriate plugs from test gauge kit. Be sure to cap trim cylinder hoses to prevent dirt from entering.
4. On trim cylinder being tested, remove "Down" trim hose (for "Down Cylinder Test") or "Up" trim hose (for "Up Cylinder Test") and install test gauge between trim hose and trim cylinder. (Figure 1 or 2)
5. With both test gauge valves open, run cylinders out-and-in a number of times to purge air from lines.



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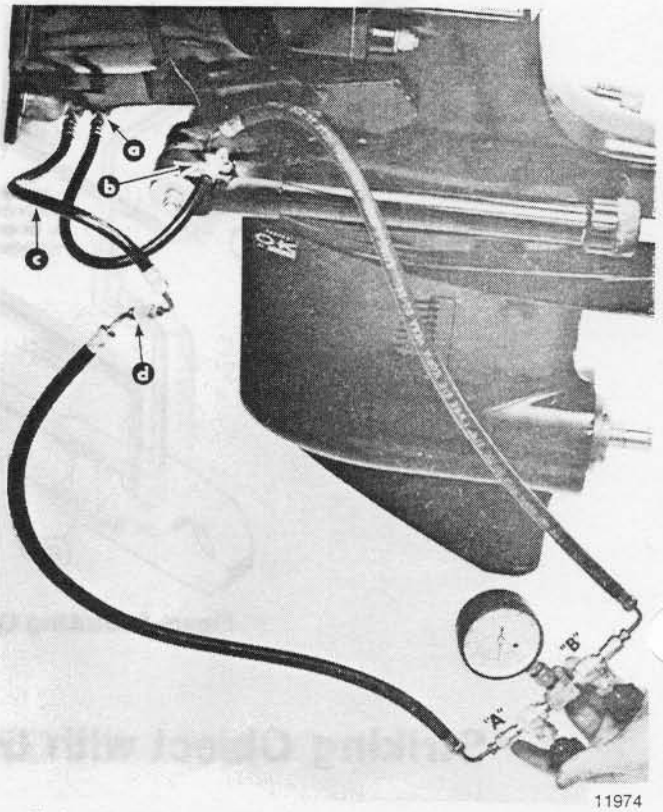
a - Hydraulic Hose Connector
b - Trim Cylinder "Down" Port
c - "Down" Hose
d - Fitting from Test Gauge Kit

Figure 1. Test Gauge Connection (for "Down Cylinder Test")



11974

a - Hydraulic Hose Connector
b - Trim Cylinder "Up" Port
c - "Up" Hose
d - Fitting from Test Gauge Kit

Figure 2. Test Gauge Connection (for "Up Cylinder Test")

"UP" CYLINDER TEST

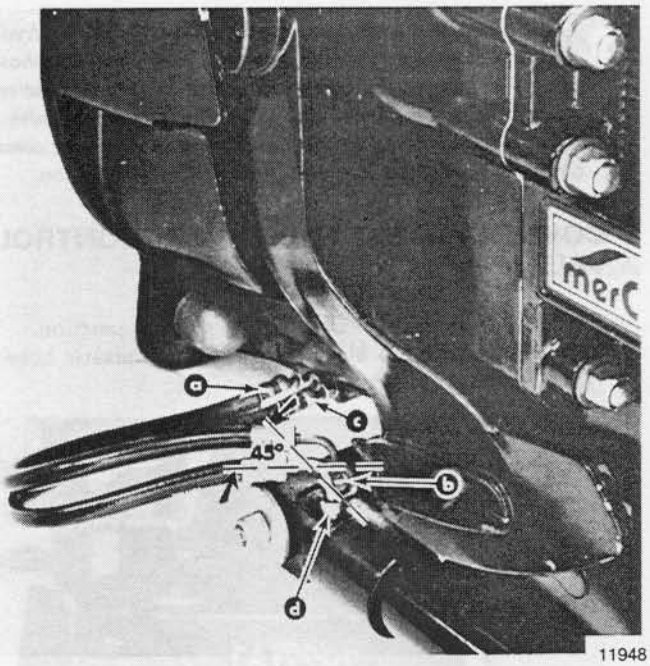
1. With both test gauge valves open, operate trim system "up" or "out" to full cylinder extension and check for external leaks at fittings and cylinder end caps.
2. Gauge pressure should be approximately 2700-3500 psi (190-246kg/cm²) at full extension and remain steady.
3. If pressure is low or unsteady close valve "B" and operate pump "up" for 3-5 seconds (Figure 2), then:
   a. If pressure remains below 2700 psi, a leak or poor pump "up" pressure is indicated. Test "Pump Up Pressure" according to instructions, following.
   b. If pressure climbs to 2700 psi (or above), a poor or leaking trim cylinder is indicated and should be repaired or replaced. Refer to "Trim Cylinder" section, following.
4. If pressure is 2700 psi or above, close valve "A" and stop pumping up, then:
   a. If pressure drops continually, an internal leak in the cylinder is indicated, and trim cylinder should be either repaired or replaced. Refer to "Trim Cylinder" section, following.
   b. If pressure remains steady, then trim cylinder is good.

"DOWN" CYLINDER TEST

1. With test gauge connected between "Down" trim hose and "Down" port on trim cylinder (Figure 1) and both test gauge valves open, operate trim system "down" or "in" to full cylinder retraction and check for external leaks at fittings and cylinder end caps.
2. Gauge pressure should be approximately 550 to 800 psi (39-56kg/cm²) at full retraction and remain steady.
3. If pressure is low or unsteady, close valve "B" while operating pump "down" (Figure 1), then:
   a. If pressure remains below 550 psi, a poor trail out valve or poor pump "down" pressure is indicated. Test both "Trail Out Valve Pressure" and "Pump Down Pressure" according to instructions, following.
   b. If pressure climbs to 550 psi (or above), a poor trim cylinder is indicated and should be either repaired or replaced. Refer to "Trim Cylinder" section, following.
4. If pressure is 550 psi or above, close valve "A" (Figure 1) and stop pumping "down", then:
   a. If pressure starts to drop, an internal leak in the cylinder is indicated and trim cylinder should be either repaired or replaced. Refer to "Trim Cylinder" section, following.
   b. If pressure remains steady, then trim cylinder is good.

TEST GAUGE REMOVAL

1. If test gauge indicates high pressure, open both test gauge valves. If test gauge still indicates pressure, run pump "down" for an instant.
2. Position drive unit in full "down" (in) position.
3. Remove test gauge hoses from trim hose and trim cylinder and reconnect trim cylinder hose to trim cylinder. Be sure that trim cylinder hose (metal tube end) is at a 45° angle to trim cylinder. (Figure 3)
4. Operate trim system and check for leaks at all connections.



11948

a - "Up" Trim Hose
b - "Up" Port of Trim Cylinder
c - "Down" Hose
d - "Down" Port of Trim Cylinder

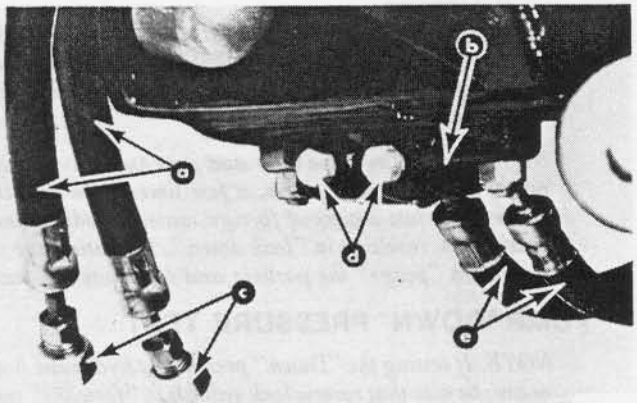
Figure 3. Trim Cylinder Hoses Properly Installed

"Up", "Down" and "Trail-Out" Pressure Tests

Test gauge may be connected to hydraulic system outside boat at hydraulic hose connector (located on bottom of gimbal housing) or inside boat at control valve (located on bottom of trim pump), depending upon accessibility of either location.

CONNECTING TEST GAUGE to HYDRAULIC HOSE CONNECTOR

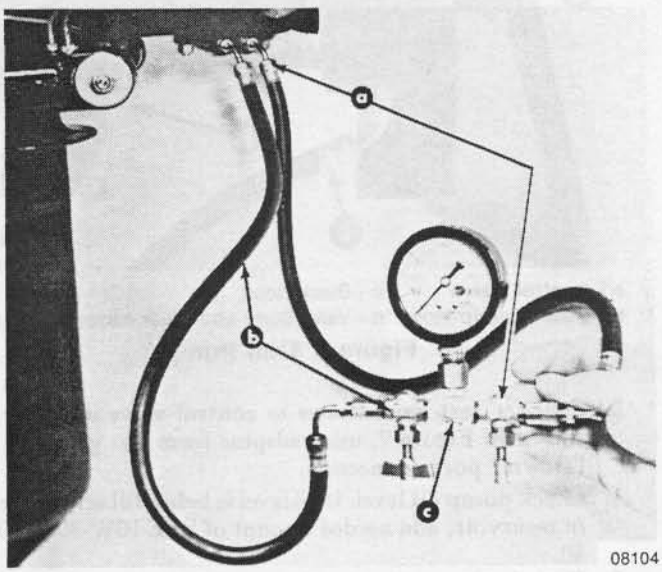
1. Position drive unit in full "down" (in) position.
2. Disconnect 4 hydraulic trim cylinder hoses from gimbal housing hydraulic hose connector. (Figure 4)



08105

a - Hoses to Trim Cylinders
b - Hydraulic Hose Connector
c - Hoses Capped (2 Each Side)
d - Plugs
e - Test Gauge Hoses

Figure 4. Hydraulic Hoses Capped



08104

a - "Up" Port Hose and Valve
b - "Down" Port Hose and Valve
c - Test Gauge Assembly

Figure 5. Hydraulic Test Gauge Installed

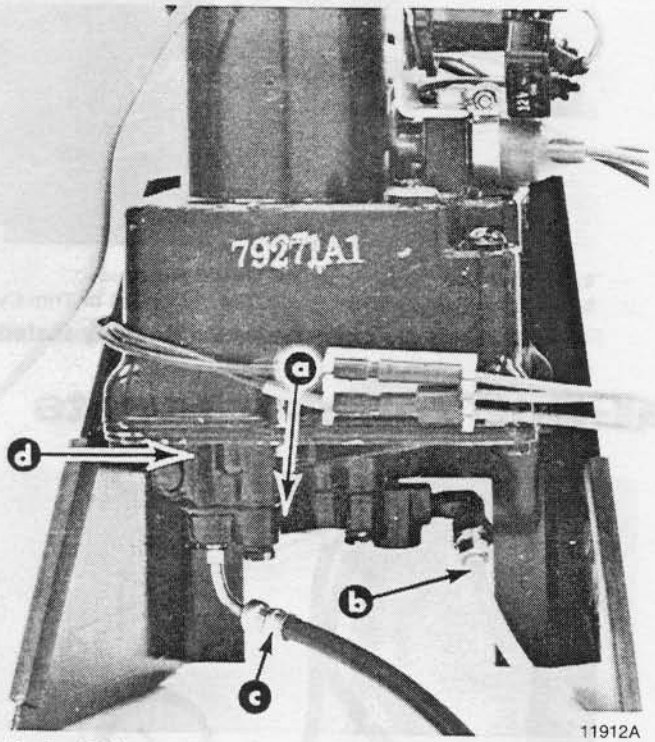
3. Cap off all 4 hoses.
4. Plug hose connections on one side of hose connector. (Figure 4)
5. Install test gauge hose to hose connections on other side of connector. (Figure 5) Be sure that all hose connections and plugs are tightened securely and do not leak.

6. Check pump oil level. If oil level is below fill screw threads in reservoir, add needed amount of SAE 10W-30 or 10W-40 automotive oil.
7. With both test gauge valves open, run pump "up" and "down" a number of times to purge air from lines.

NOTE: Test gauge hose, that is connected to front of hydraulic hose connector, will be referred to as, "Up" port hose and valve. Test gauge hose, that is connected to aft hose connection, will be referred to as "Down" port hose and valve. (Figure 5) Also, when test gauge is connected at hose connector, reverse lock valve should be in "forward" position.

CONNECTING TEST GAUGE to CONTROL VALVE

1. Position drive unit in full "down" (in) position.
2. Remove and cap black hose and clear plastic hose from control valve. (Figure 6)

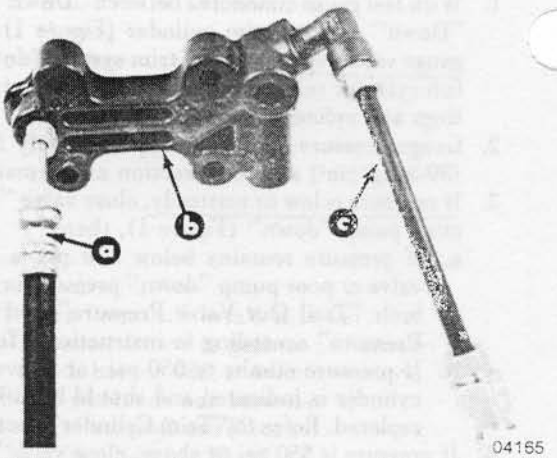


a - Control Valve
b - Clear Plastic Hose
c - Black Hose
d - Valve Body and Gear Assembly (Pump)

Figure 6. Trim Pump

3. Connect test gauge hoses to control valve assembly, as shown in Figure 7, using adaptor from test gauge kit for "Down" port connection.
4. Check pump oil level. If oil level is below fill screw threads in reservoir, add needed amount of SAE 10W-30 or 10W-40.
5. With both test gauge valves open, run pump "up" and "down" a number of times to purge air from lines.

NOTE: Test gauge hose, that is connected to "Up" port, will be referred to as "Up" port hose and valve. Test gauge hose, that is connected to "Down" port, will be referred to as "Down" port hose and valve. (Figure 7)



a - "Up" Port b - Pump Control Valve c - "Down" Port

Figure 7. Hose Connections

PUMP "UP" PRESSURE TEST

NOTE: Refer to "Test Gauge Removal", following, before removing test gauge.

1. Close "Down" port valve and open "Up" port valve. (Figure 5 or 7)
2. Run pump in "up" direction until pressure stops rising, as indicated on gauge. Pump output "Up" pressure should be a minimum of 2700 psi (190kg/cm²).
3. Stop pumping "up". Gauge pressure should drop slightly, then hold steady.
4. If gauge indicates "low pressure" or "low pressure and does not hold steady":
   a. Check for leaks at all connections. Tighten or replace hoses, if necessary.
   b. Check area between control valve and valve body (Figure 6) for indication of leak around "O" rings. Replace if necessary.
   c. If steps (a) and/or (b) do not remedy problem, a poor check valve (inside pump) is indicated, and replacement of valve body and gear assembly is required. Refer to "Hydraulic Pump" section, following.
5. If gauge indicates at least 2700 psi but does not hold steady:
   a. Check for leaks around control valve and at all hose connections. Replace hoses or control valve "O" rings, if necessary.
   b. If step (a) does not remedy problem, a poor check valve is indicated, and replacement of valve body and gear assembly is required. Refer to "Hydraulic Pump" section, following.

NOTE: If a faulty valve body and gear assembly is suspected, repeat Steps 1-thru-5, above, a few times to be sure that the cause is not just a piece of foreign material lodged under the check balls, resulting in "leak down". Repeating the test can sometimes "purge" the particle and eliminate the leak.

PUMP "DOWN" PRESSURE TEST

NOTE: If testing the "Down" pressure at hydraulic hose connector, be sure that reverse lock valve is in "forward" position. Also, refer to "Test Gauge Removal", following, before removing test gauge.

1. Open "Down" port valve and close "Up" port valve. (Figure 5 or 7)
2. Run pump in "Down" direction and note gauge reading. Reading should be approximately 550 to 800 psi (49-56 kg/cm²).
3. Stop pumping "down". Pressure should drop slowly and may possibly become steady around 100 psi (7kg/cm²) or drop to zero psi.
4. If gauge indicates less than 500 psi while pumping down:
   a. Check for leaks at all connections. Tighten or replace hoses and/or fittings, if necessary.
   b. Check reverse lock valve for leaks around top cover. Replace "O" ring, if necessary.
   c. Check area between control valve and valve body for indication of a leak around "O" rings. Replace "O" rings, if necessary.
   d. If (a), (b) or (c) do not remedy problem, then test the trail-out valve according to instructions, following. If test indicates a poor trail-out valve (causing low "Down" pressure) replace control valve. (Figure 6) If trail-out valve tests OK, then a poor check valve in valve body is indicated, and replacement of valve body and gear assembly (Figure 6) is necessary. Refer to "Hydraulic Pump" section, following.

"TRAIL-OUT" VALVE PRESSURE TEST

NOTE: Reverse lock valve should be in "forward" position if test gauge is connected at hydraulic hose connector.

1. Open "Up" port and "Down" port valves. (Figure 5 or 7)
2. Run pump in "up" direction and note gauge reading. Reading should be 550-1100 psi (39-77kg/cm²).
3. Stop pumping "up". Gauge readings may either stabilize or drop slowly to zero (both conditions being normal).

NOTE: Refer to "Test Gauge Removal" before removing test gauge.

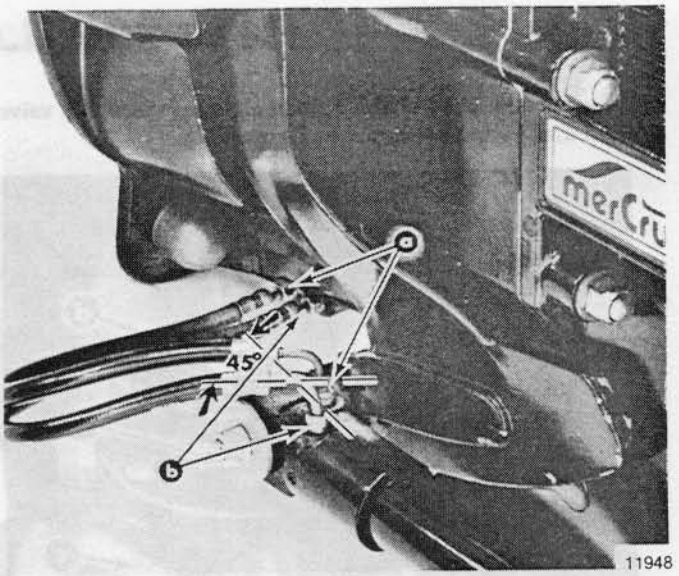
4. If gauge indicates less than 550 psi while pumping down:
   a. Check fittings and reverse lock valve for leaks. Tighten or replace fittings and/or "O" ring in reverse lock valve.
   b. Test "Up" pressure (if not already done). If "Up" pressure test is good, then a bad trail-out valve is indicated and replacement of control valve is necessary.

REMOVING TEST GAUGE from HYDRAULIC HOSE CONNECTOR

1. If test gauge indicates high pressure, open both "Down" port and "Up" port valves. If test gauge still indicates pressure, run pump "down" for an instant.
2. Remove test gauge hoses and plugs from hydraulic hose connector.
3. Remove caps from hydraulic trim cylinder hoses.

NOTE: When installing trim cylinder hoses, be sure that metal ends of hoses are at a 45° angle to trim cylinders, as shown in Figure 8.

4. Install aft trim cylinder hoses to aft hose connections on hydraulic connector. (Figure 8)
5. Install front trim cylinder hose to front hose connections on connector. (Figure 8)
6. Operate trim system and check for leaks at all connections.



a - Front Hose Connections b - Aft Hose Connections

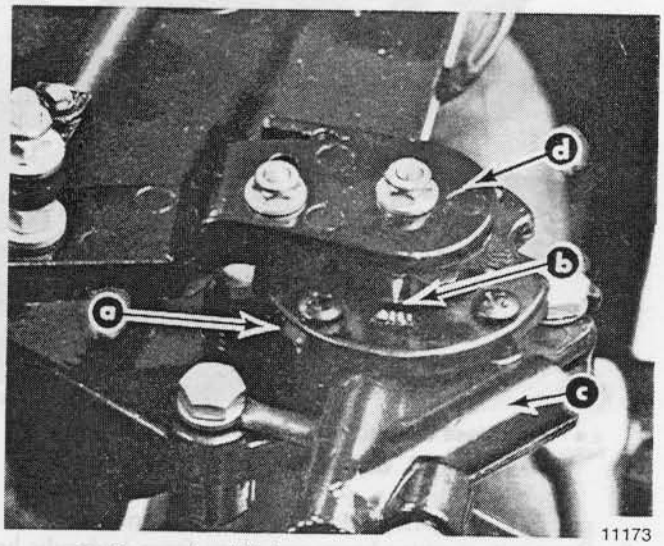
Figure 8. Connecting Trim Hoses

REMOVING TEST GAUGE from CONTROL VALVE

1. If test gauge indicates high pressure, open both "Down" port and "Up" port valves. If test gauge still indicates pressure, run pump "down" for an instant.
2. Remove test gauge hoses from pump.
3. Uncap and install black hydraulic hose to "Up" port on control valve. (Figure 6)
4. Uncap and install clear plastic hose to "Down" port on control valve. (Figure 6)
5. Operate trim system and check for leaks at all connections.

Reverse Lock Valve Test

This test is to be used ONLY on new style reverse lock valves with a relief valve, as shown in Figure 9.

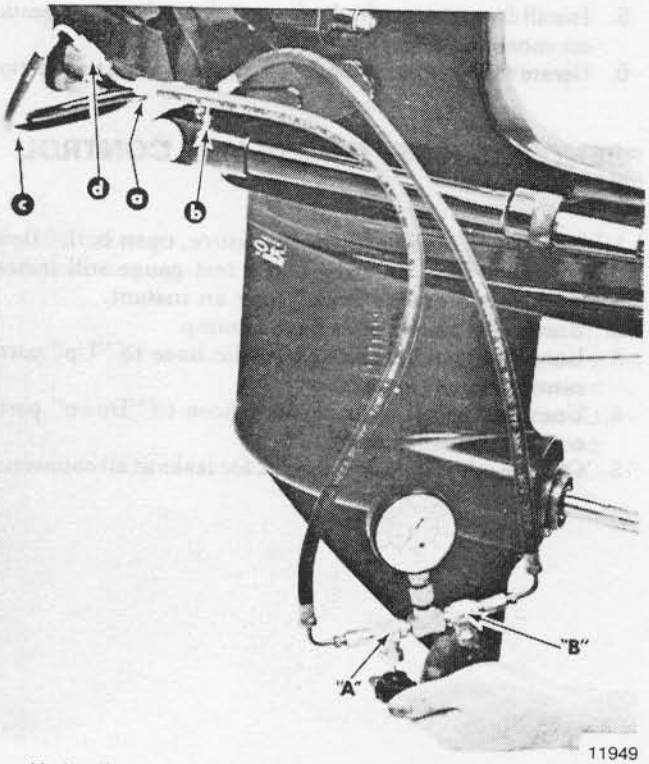


a - Reverse Lock Valve
b - Alignment Marks
c - Relief Valve Barrel
d - Shift Lever

Figure 9. Reverse Lock Valve in Closed (Reverse) Position

INSTALLING TEST GAUGE

1. Position drive unit in full "down" (in) position.
2. Remove trim cylinder hose from "Down" port of trim cylinder. (Figure 10)



a - Hydraulic Hose Connector
b - Trim Cylinder "Down" Port
c - "Down" Hose
d - Fitting from Test Gauge Kit

Figure 10. Test Gauge Connection for Reverse Lock Valve Test

3. Install test gauge between trim hose and trim cylinder. using fitting from kit, as shown in Figure 10.

NOTE: Test gauge also can be connected between reverse lock valve and gray hydraulic hose (from gimbal housing), if area is accessible.

TESTING REVERSE LOCK VALVE

CAUTION: DO NOT allow pressure (indicated on gauge) to exceed 4,500 psi (316kg/cm²), or trim cylinder damage may occur. Also, DO NOT close either test gauge valve while operating pump in "up" direction, as trim cylinders could rupture.

1. Open BOTH valves of test gauge.
2. Position reverse lock valve in open position (shift to "forward").
3. With drive unit in full "down" position and BOTH test gauge valves open, operate pump in "up" direction. If gauge reading exceeds 3500 psi (246kg/cm²), a problem inside reverse lock valve is indicated, and reverse lock valve either should be repaired or replaced (refer to "Reverse Lock Valve" section, following.
4. Position reverse lock valve in "closed" position (shift into reverse), aligning mark on reverse lock valve housing with mark on shift lever. (Figure 9)
5. With BOTH valves of test gauge open, operate pump in "up" direction and note test gauge reading. Gauge should indicate in the range of 3800 to 4200 psi (267-295kg/cm²). If gauge reading is lower or higher than described range (and trim pump tests OK), replace reverse lock valve.
6. Stop pumping "up", then quickly close valve "B". (Figure 10) Gauge reading should fall to between 1500-2500 psi (105-176kg/cm²), slowly drop at a rate of 100 psi (7kg/cm²) every 15-20 seconds. If leak down rate is much faster than described, replace the reverse lock valve.

TEST GAUGE REMOVAL

CAUTION: If pressure is still indicated on gauge after slowly shifting reverse lock valve into "neutral" or "forward" position, and after opening valve "B", DO NOT operate pump in "up" direction, or trim cylinders could rupture.

1. Shift reverse lock slowly to "neutral" or "forward" (open) position.
2. Open valve "B" slowly, then press "Down" button of trim control momentarily or until drive unit is in a full "down" (in) position.
3. Remove test gauge hoses from trim hose and trim cylinder (if connected at this loction), then reconnect trim cylinder hose to trim cylinder.

NOTE: If test gauge is connected at reverse lock valve, remove test gauge and reconnect gray hydraulic hose to reverse lock valve.

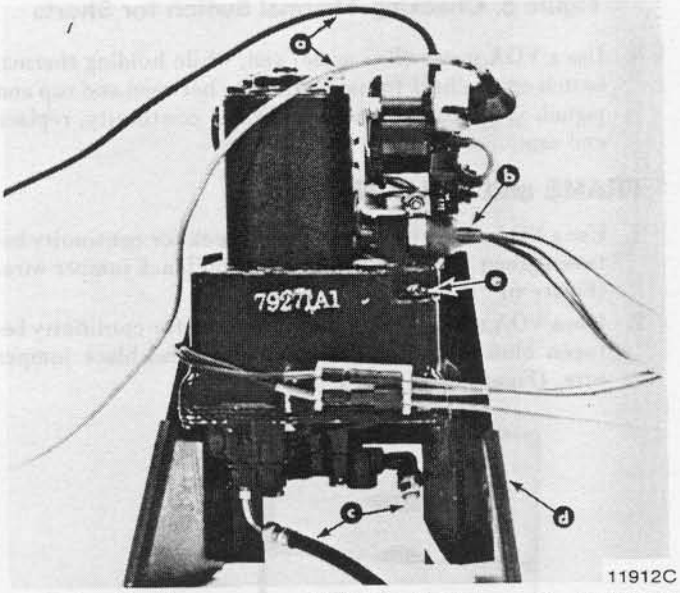
4. Check oil level in trim pump and add, if necessary. Operate trim system and check for leaks at all connections. Recheck oil level and be sure to reinstall fill screw in pump.

HYDRAULIC TRIM PUMP

NOTE: The following instructions are for complete disassembly and reassembly of pump. In many cases, however, complete disassembly of pump is not required and, in those cases, it is necessary only to perform the operations which are required to replace the faulty part.

Removal and Disassembly (Figure 1)

1. Position drive unit in full "down" (in) position.
2. Disconnect trim pump battery leads from battery, remove other end of black wire from solenoid and remove other end of red wire from fuse.
3. Disconnect trim control harness from trim pump.
4. Disconnect hydraulic hoses from bottom of pump. Cap hoses and plug hose connections.
5. Remove pump from mounting bracket on V-8 configuration or from transom plate on In-Line configuration.

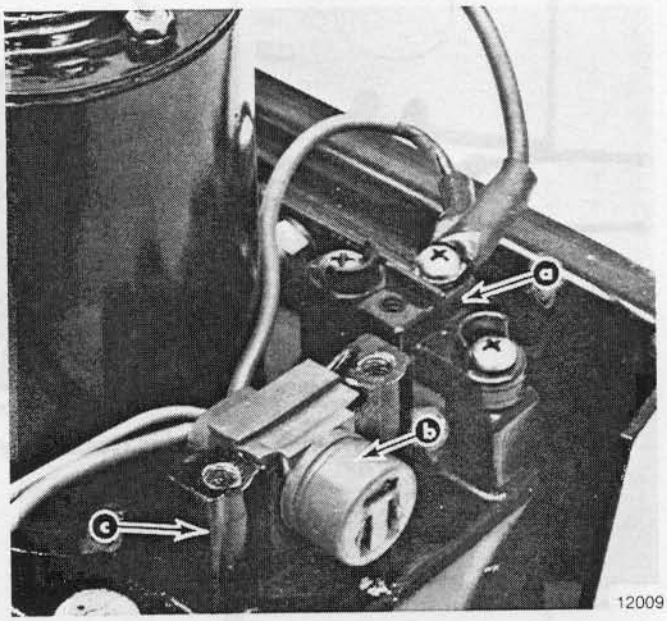


11912C

a - Battery Leads
b - Trim Control Harness
c - Hydraulic Hoses
d - Bracket (V-8 Models)
e - Fill Screw

Figure 1. Hydraulic Trim Pump

6. Remove "Fill" screw (Figure 1) and drain oil.
7. Remove 4 screws from control valve assembly and separate control valve from body. (Figure 8)
8. Remove 8 screws, which secure valve body to reservoir, and separate valve body from reservoir. (Figure 8)



12009

a - Terminal Block (if Equipped)
b - Harness Connector
c - Reservoir

Figure 2. Removing Harness Connector

9. Disconnect motor leads from solenoids (or solenoid) and terminal block (if equipped).
10. Remove solenoid (or solenoids) from mounting bracket and remove mounting bracket from pump.
11. Remove harness connector and terminal block (if equipped) from reservoir. (Figure 2)
12. Remove 2 long screws, which secure pump motor to reservoir, and separate field frame from reservoir. Be careful not to lose ball located on end of armature shaft. (Figure 1)
13. Remove armature from reservoir and remove 2 washers from armature shaft. (Figure 8)
14. Separate commutator end plate from pump. Be sure not to lose brush springs. (Figure 8)

Electrical Testing

ARMATURE INSPECTION and TESTING

1. Inspect commutator for pits, grooves from brushes, dirty bars or flat spots. If any of these conditions cannot be cleaned up with "00" sandpaper, replace armature assembly. DO NOT use emery cloth and, after using sandpaper, clean slots between commutator bars.
2. Test armature assembly on growler. (Follow growler manufacturer's test instructions.) Any indication of shorts or open windings requires replacement of armature assembly.

END CAP TESTING

1. Inspect condition of brushes. Replace, if pitted, chipped or worn to ¼" (6.4mm).

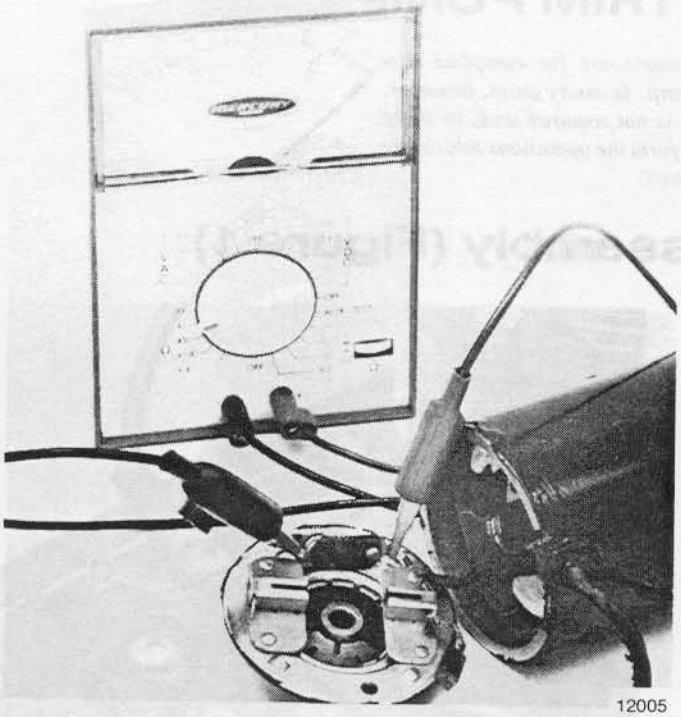


Figure 3. Checking Thermal Switch for Continuity

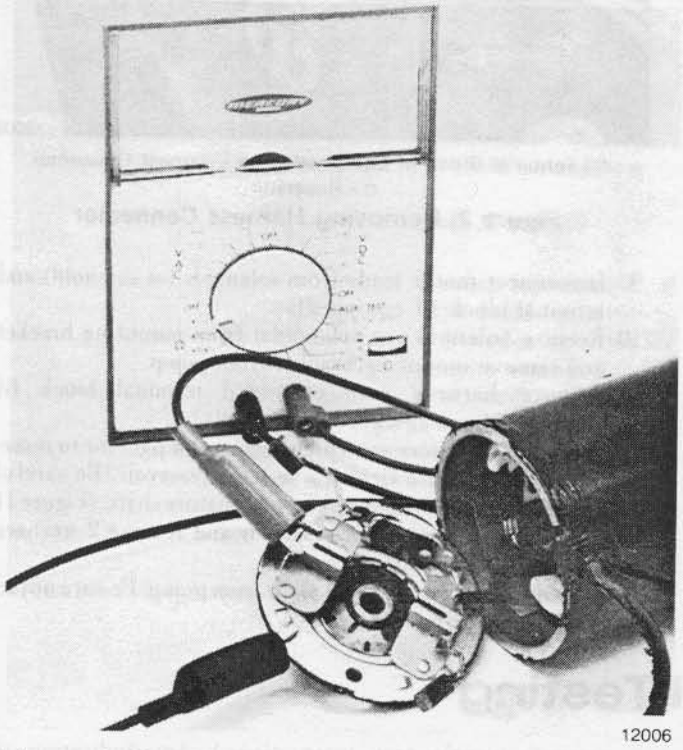


Figure 4. Checking for No Continuity between Brush Holders and End Cap

2. Check thermal switch for full continuity. Connect leads of VOA meter (Rx1 scale) between brush pigtail and opposite end of thermal switch, as shown in Figure 3. If meter indicates no continuity or high resistance, replace end plate.
3. Use a VOA meter (Rx1 scale) and check for no continuity between brush holders and end cap. (Figure 4) If meter indicates continuity, replace end cap.

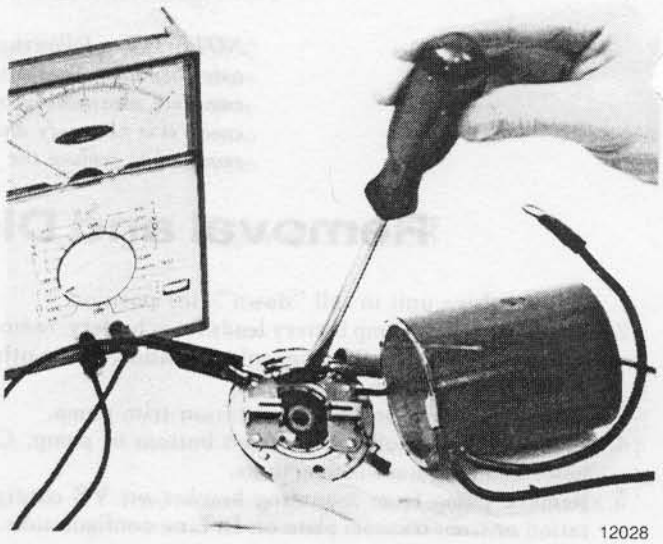


Figure 5. Checking Thermal Switch for Shorts

4. Use a VOA meter (Rx1 scale) and, while holding thermal switch open, check for no continuity between end cap and pigtail. (Figure 5) If meter indicates continuity, replace end cap.

FRAME and FIELD TESTING

1. Use a VOA meter (Rx1 scale) and check for continuity between green (or green-white wire) and black jumper wire. (Figure 6)
2. Use a VOA meter (Rx1 scale) and check for continuity between blue wire (or blue-white wire) and black jumper wire. (Figure 6)

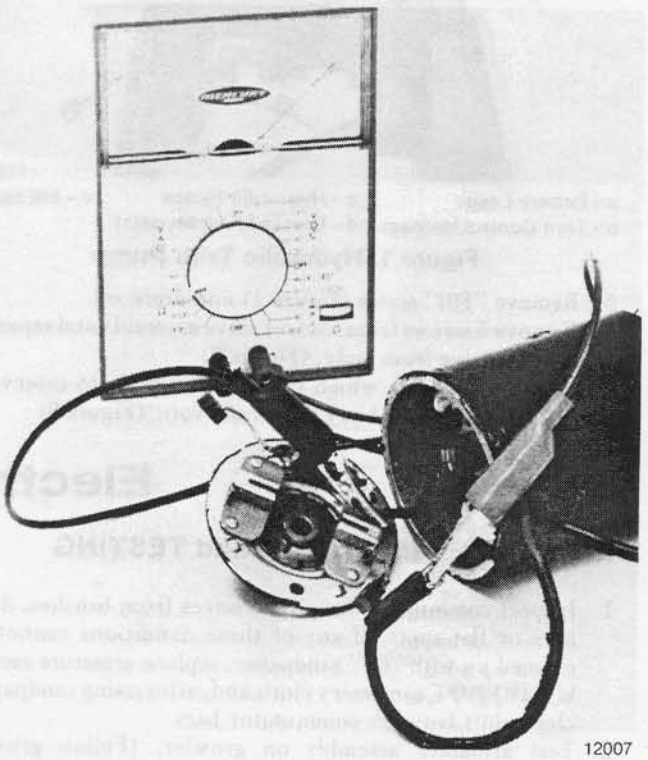
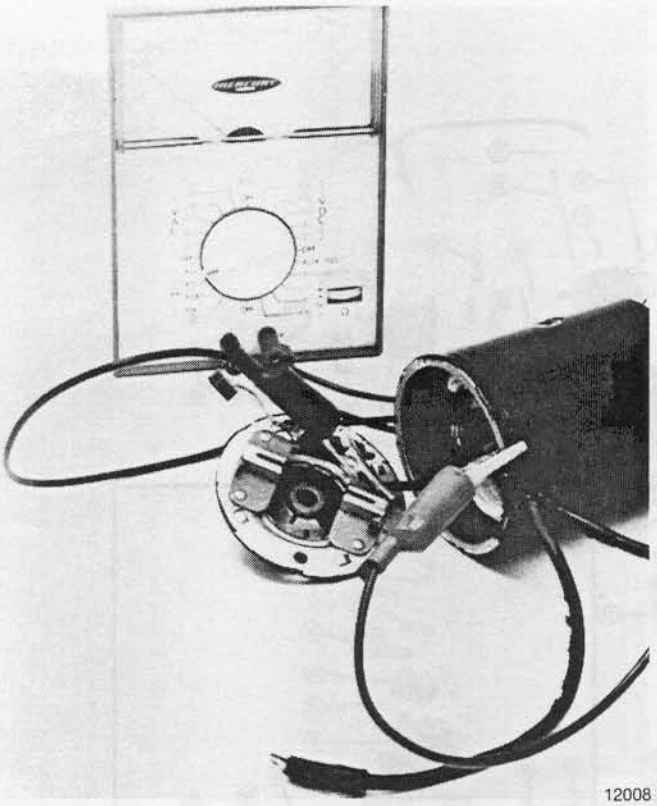


Figure 6. Testing for Continuity between Field Leads and Black Jumper Wire



3. If motor indicates no continuity or high resistance on any of preceding tests, replace frame and field assembly.
4. Use VOA meter (Rx1 scale) and check for no continuity between black jumper wire and frame. (Figure 7) If a short between frame and black jumper exists (meter shows continuity), replacement of frame and field assembly is required.

SOLENOID TEST

1. Connect 12 volts across small terminals of solenoid.
2. Test for continuity between large terminals of solenoid.
3. Remove 12 volts from solenoid small terminals. No continuity should exist between large terminals.
4. If solenoid fails any of the preceding tests, replacement is necessary.

Figure 7. Testing for Shorts between Field Assembly and Black Jumper Wire

Reassembly

CAUTION: Work in clean, lint-free area. Lubricate parts with SAE 10W-30 or 10W-40 automotive oil after cleaning parts.

1. Place small can over inlet screen of valve body and gear assembly. (Figure 8)

   IMPORTANT: Small can must be secure in position over inlet screen, or air could be induced into trim system during operation.

2. Place small amount of Liquid Neoprene (C-92-25711) in seal groove of valve body and gear assembly to hold seal in position during installation.

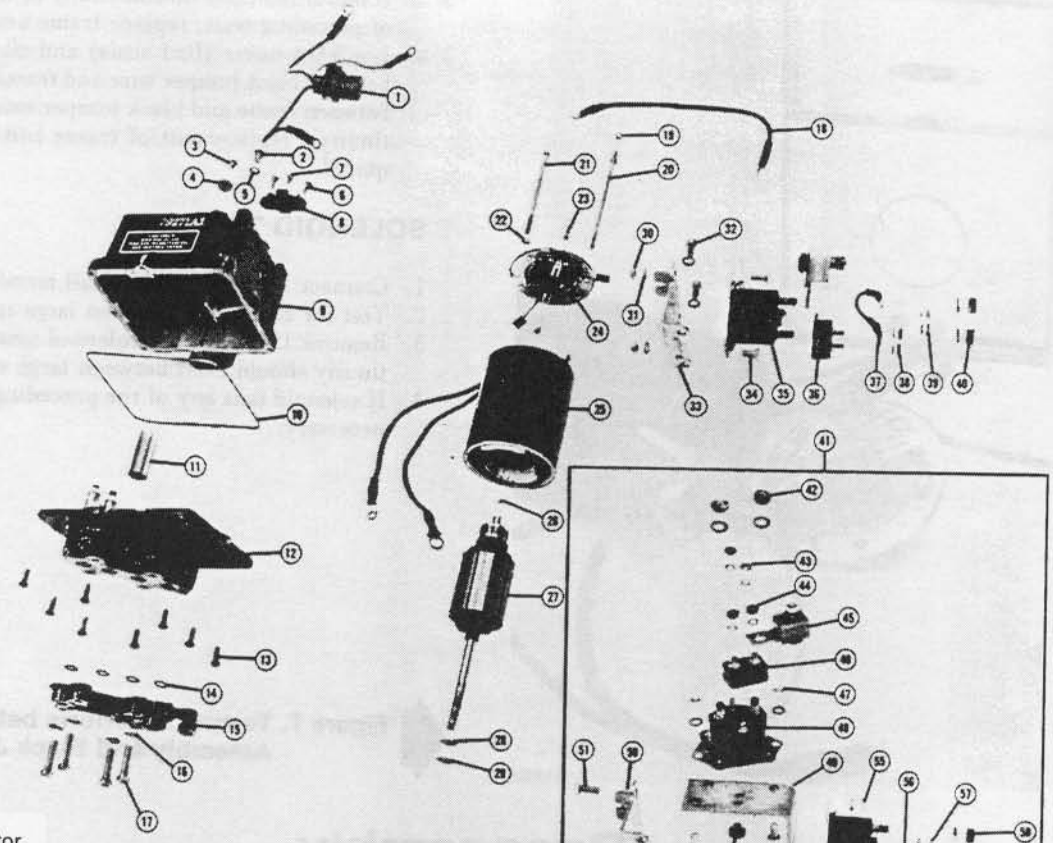
CAUTION: DO NOT use Liquid Neoprene in excess or allow it to enter valve and gear assembly.

3. Install new seal on valve body and gear assembly.
4. Install valve body and gear assembly to reservoir with 8 screws and tighten evenly.
5. Place new "O" rings on valve body, install control valve to valve body (Figure 8) with 4 screws and tighten evenly.
6. Place plastic washer, then fiber washer, on bottom of armature shaft. (Figure 8) Insert armature into reservoir, being sure that it engages into pump gears.

CAUTION: Solder, that is used to install new brushes, must be rosin core and have a melting point above 350°F (177°C). Use a soldering gun to solder. DO NOT use a torch.

7. If testing determines that brushes should be replaced, replace brushes as follows:
   a. Cut old brush shunt at point where brush is connected to end cap.
   b. Solder new brush shunt to connection point, using rosin core solder 40-60 tin-lead alloy or equivalent rosin core solder that has a melting point above 350°F. DO NOT use acid core solder, because of corrosive action of acid.

(Continued on Page 5-15)



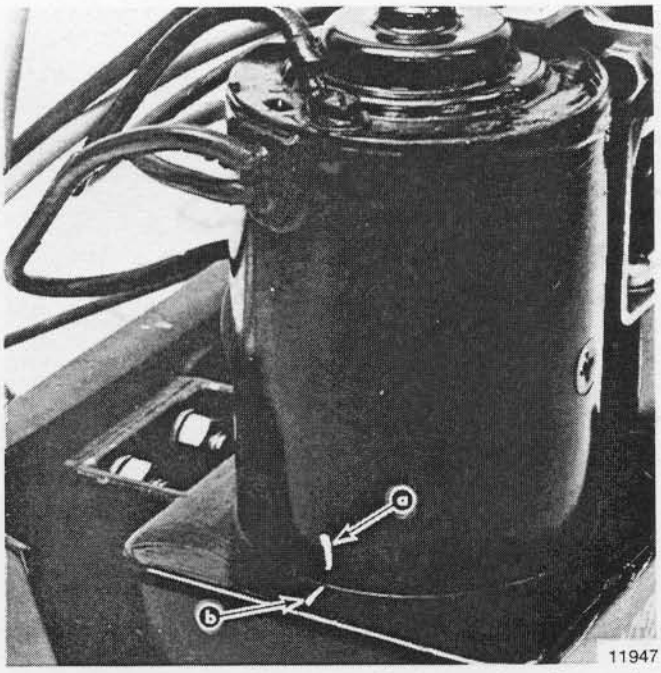
1 - Harness Connector
2 - Fill Screw
3 - Vent Screw
4 - Washer
5 - "O" Ring
6 - Terminal Block to Pump Reservoir Attaching Screws (2)
7 - Green or Green/White Wire to Terminal Block Attaching Screw
8 - Terminal Block

For Single Solenoid Pump Only

9 - Pump Reservoir
10 - "O" Ring
11 - Inlet Cam
12 - Valve Body and Gear Assembly
13 - Valve Body to Reservoir Screw (8)
14 - "O" Rings (4)
15 - Control Valve
16 - Lock Washer (4)
17 - Control Valve to Pump Screw (4)
18 - Pump to Solenoid Black Wire
19 - Solenoid Bracket to Pump Mounting Nut
20 - End Plate and Field Frame Mounting Bolt (Hex Head)
21 - End Plate and Field Frame Mounting Bolt
22 - Lockwasher
23 - Brush Spring (2)
24 - End Plate
25 - Field and Frame Assembly
26 - Ball Bearing
27 - Armature
28 - Fiber Washer
29 - Washer
30 - Solenoid to Bracket Nut (2)
31 - Lockwasher (2)
32 - Bracket to Reservoir Screw and Lockwasher (2)
33 - Solenoid Bracket
34 - Solenoid to Bracket Bolt (2)
35 - Solenoid
36 - 20 Amp Circuit Breaker
37 - Large Solenoid Terminal to Circuit Breaker Red Wire
38 - Wire to Circuit Breaker Attaching Nut and Lockwasher (2)
39 - Wire to Solenoid Small Terminal Attaching Nut and Lockwasher (2)
40 - Fuse or Wire to Solenoid Attaching Nut and Lockwasher (2)
41 - For Dual Solenoid Pump
42 - Fuse or Wire to Solenoid Attaching Nut and Lockwasher (2)
43 - Wire to Solenoid (Small) Nut and Lockwasher
44 - Wire to Circuit Breaker Attaching Nut and Lockwasher (2)
45 - Fuse
46 - Circuit Breaker
47 - Solenoid to Bracket Attaching Nut and Lockwasher (2)
48 - Solenoid
49 - "L" Bracket
50 - Solenoid Bracket
51 - Solenoid to Bracket Attaching Bolt (2)
52 - Solenoid to Bracket Attaching Bolt
53 - Rubber Bumper
54 - Solenoid
55 - Solenoid to Bracket Attaching Nut and Lockwasher (2)
56 - Extension Bracket
57 - Wire to Solenoid Small Terminal Attaching Nut and Lockwasher (2)
58 - Wire to Solenoid Large Terminal Attaching Nut and Lockwasher (2)
59 - Green or Green/White Wire to Extension Bracket Attaching Screw
60 - Circuit Breaker to Fuse Red Wire
61 - Solenoid to Solenoid Black Wire
62 - Solenoid to Solenoid Red or Red/Purple Wire

12027

Figure 8. Trim Pump Reassembly

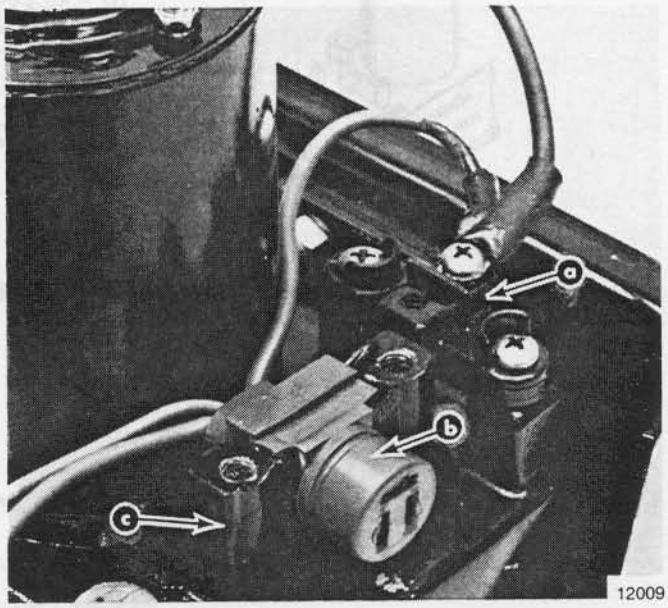


a - Indentation on Field Frame b - Embossment on Reservoir

Figure 9. Alignment Marks on Trim Pump

8. Place field and frame assembly on reservoir. Match the mark on field frame with mark or reservoir. (Figure 9)
9. Place ball on top of armature shaft. (Figure 8)
10. Install upper end cap assembly as follows:
    a. Place springs in brush holders.
    b. Depress brushes into holders and slide upper end cap assembly over commutator.
11. Install long screws into end cap assembly (Figure 8), including ground wire under round head screw. Position round head screw (through end cap) on side of trim pump in location shown in Figure 8.
12. Place harness connector in groove on reservoir body and install terminal block, if so equipped. (Figure 10)
13. Install solenoid(s) to bracket, then install solenoid mounting bracket to reservoir body and the pump motor thru bolt. (Figure 8)
14. Install fuse and circuit breaker (Figure 8) and make wire connections as shown in Figures 11, 12, 13 or 14. DO NOT connect battery leads to battery at this time.

(Continued on Page 5-17)



a - Terminal Block b - Harness Connector c - Pump Reservoir

Figure 10. Installing Harness Connector

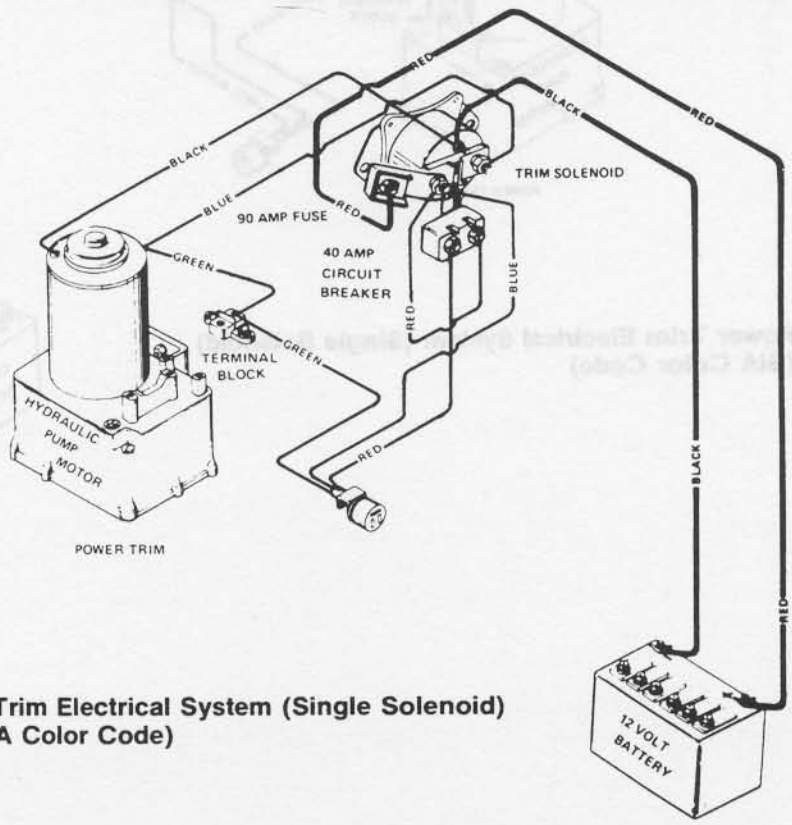


Figure 11. Power Trim Electrical System (Single Solenoid) (Pre-BIA Color Code)

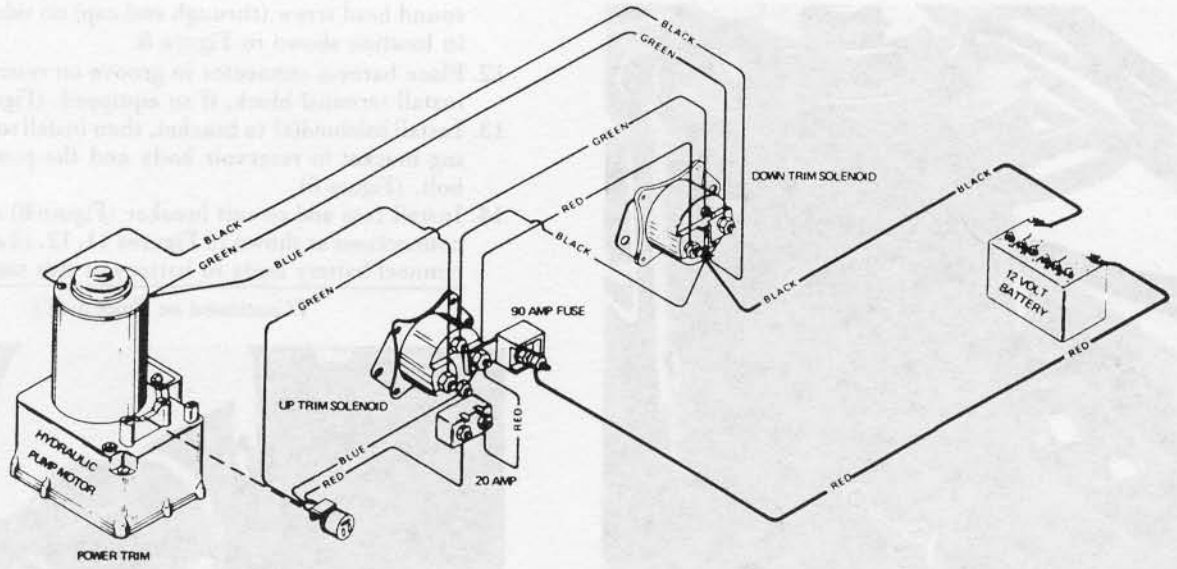


Figure 12. Power Trim Electrical System (Dual Solenoid) (Pre-BIA Color Code)

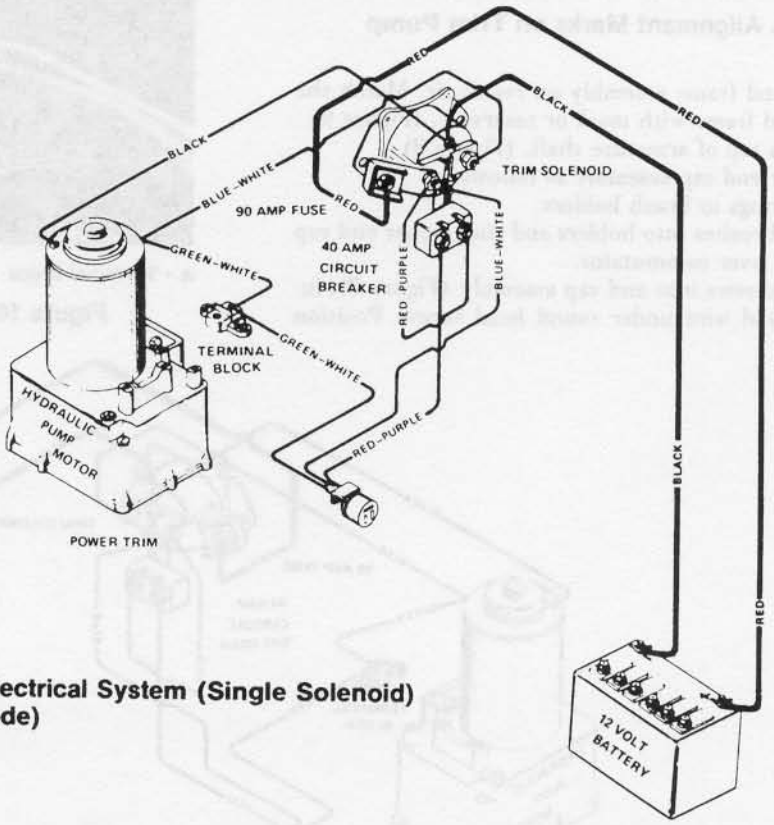


Figure 13. Power Trim Electrical System (Single Solenoid) (BIA Color Code)

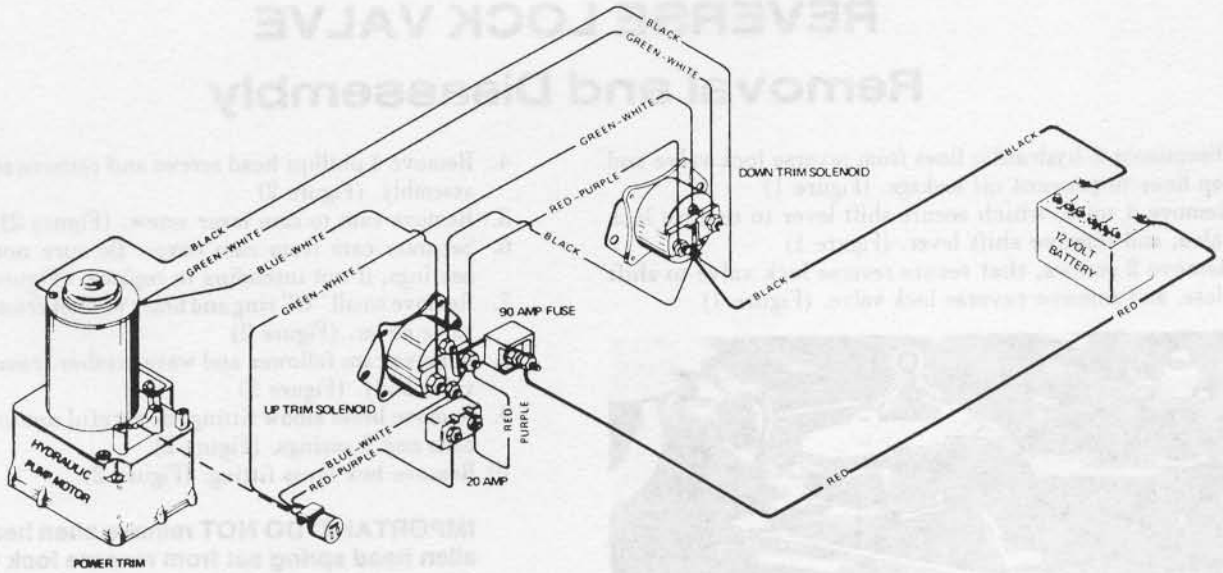
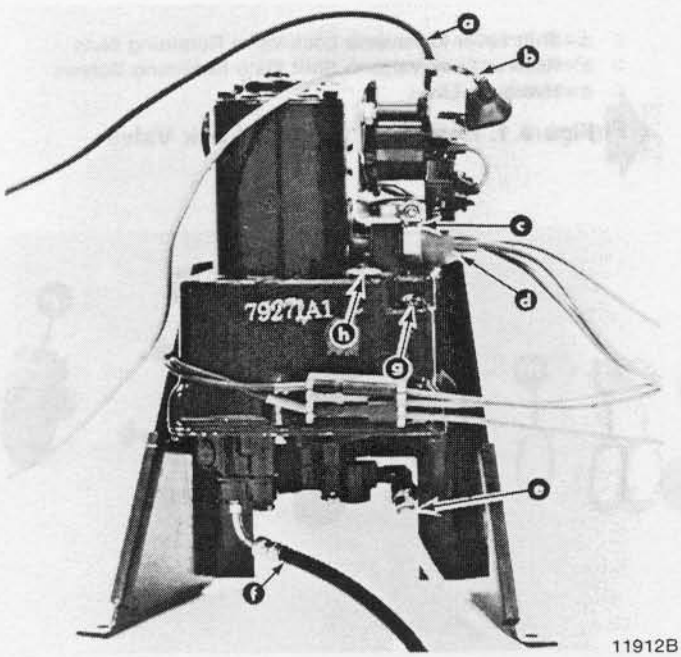


Figure 14. Power Trim Electrical System (Dual Solenoid) (BIA Color Code)



15. Install pump to mounting bracket.
16. Remove plugs from control valve, uncap hydraulic hoses and quickly connect hoses to control valve, as shown in Figure 15.
17. Connect trim control harness to harness connector and secure with clamp. (Figure 15)
18. Connect red, then black, battery lead from trim pump to battery. Be sure that rubber boot on red wire is in place over fuse lug. (Figure 15)
19. Be sure that "Vent" screw (Figure 15) is open 2 turns, then remove "Fill" screw and fill reservoir with SAE 10W-30 or SAE 10W-40 automotive oil to bottom of "Fill" screw hole threads. Reinstall "Fill" screw.
20. Operate trim system a number of times to purge air from system and also to check for correct operation.

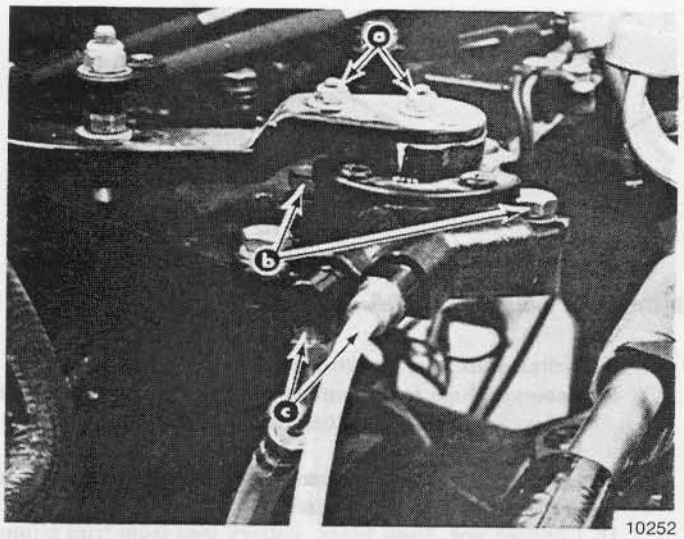
a - Black (-) Battery Lead
b - Red (+) Battery Lead
c - Clamp, Screw and Locknut
d - Trim Control Harness
e - Clear Plastic Hose
f - Black Hydraulic Hose
g - "Fill" Screw
h - "Vent" Screw

Figure 15. Trim Pump Installed

REVERSE LOCK VALVE

Removal and Disassembly

1. Disconnect 2 hydraulic lines from reverse lock valve and cap lines to prevent oil leakage. (Figure 1)
2. Remove 2 nuts, which secure shift lever to reverse lock valve, and remove shift lever. (Figure 1)
3. Remove 2 screws, that secure reverse lock valve to shift plate, and remove reverse lock valve. (Figure 1)



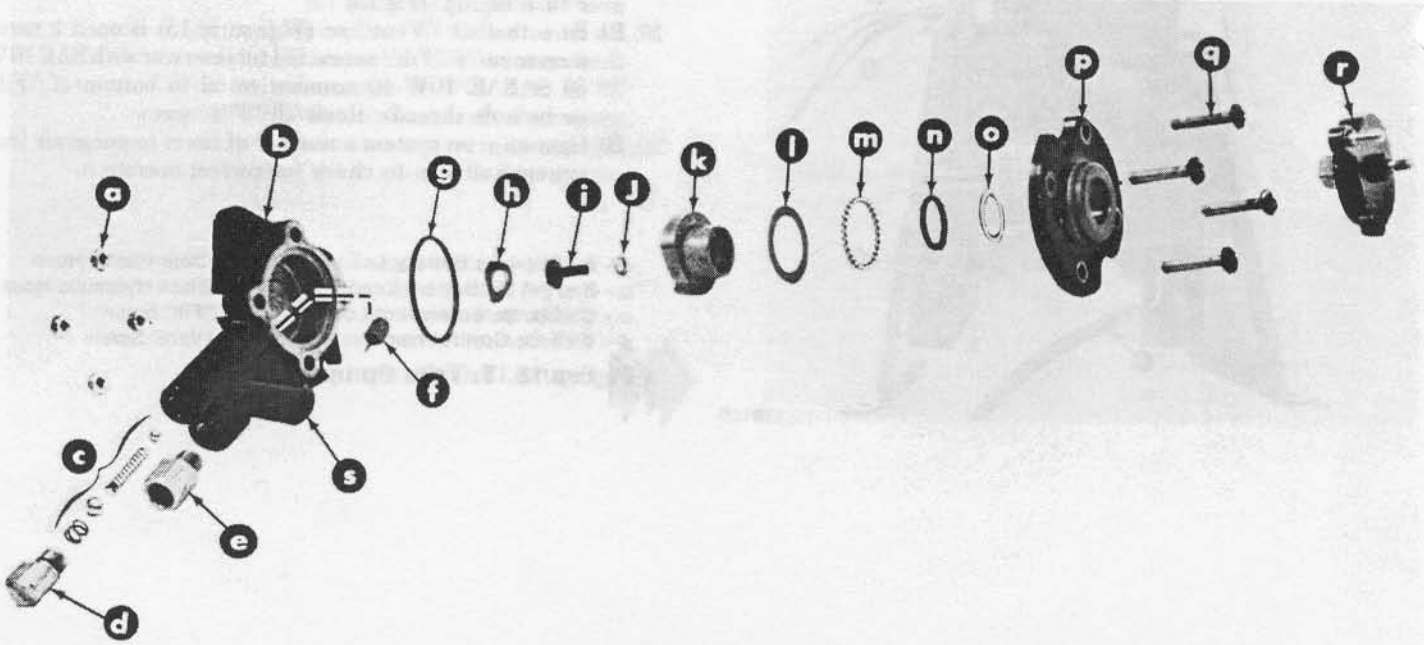
10252

a - Shift Lever to Reverse Lock Valve Retaining Nuts
b - Reverse Lock Valve to Shift Plate Retaining Screws
c - Hydraulic Lines

Figure 1. Removing Reverse Lock Valve

4. Remove 4 phillips head screws and remove cover and cam assembly. (Figure 2)
5. Remove cam to cam lever screw. (Figure 2)
6. Separate cam from cam cover. Be sure not to lose ball bearings, if not intending to replace. (Figure 2)
7. Remove small "O" ring and brass washer from reverse lock valve cover. (Figure 2)
8. Remove cam follower and wave washer from reverse lock valve body. (Figure 2)
9. Remove brass elbow fitting. Be careful not to lose 2 check balls and 2 springs. (Figure 2)
10. Remove hex brass fitting. (Figure 2)

IMPORTANT: DO NOT remove allen head plug and allen head spring set from reverse lock valve body. (Figure 2) Check ball is preset at factory.



12002

a - Locking Nuts (4)
b - Reverse Lock Valve Body
c - Valve and Check Ball Assembly
d - Elbow Fitting
e - Straight Fitting
f - Cam Follower
g - Large "O" Ring
h - Wave Washer
i - Cam to Cam Lever Screw
j - Lockwasher
k - Cam
l - Retaining Washer
m - Bearings (30)
n - Small "O" Ring
o - Brass Washer
p - Cover
q - Cover to Reverse Lock Valve Body Screws (4)
r - Lever
s - DO NOT Remove Plug in This Location

Figure 2. Reverse Lock Valve Assembly

Reassembly and Installation

CAUTION: Work in clean, lint-free area. Lubricate parts with SAE 10W-30 or 10W-40 automotive oil after cleaning parts.

1. Insert small check ball (removed in disassembly) into straight passage that leads to large cavity in reverse lock valve body. (Figure 2)
2. Insert longer spring, large check ball and shorter spring (in that order) on top of check ball (installed in Step 1), then install brass elbow fitting. (Figure 2)
3. Install brass hex fitting to reverse lock valve body.
4. Reassemble cover and cam assembly according to sequence shown in Figure 2. Apply Loctite Type "A" to threads of cam to cam cover screw before installing.
5. Position cam follower into reverse lock valve main passage with shaft of follower pointing toward check balls. (Figure 2)
6. Position wave washer in reverse lock valve cavity so that the 2 flat parts of washer are contacting the bottom of the cavity. (Figure 2)
7. Install large "O" ring to reverse lock valve body and install cover and cam assembly. Align notches in cover with mounting holes in main body. Secure cover with phillips head screws and nylon locknuts. (Figure 2) Tighten securely and evenly.
8. Secure reverse lock valve to shift plate with 2 screws tightened securely. (Figure 1)
9. Attach shift lever to reverse lock valve with 2 nuts and lockwashers. (Figure 1) Tighten nuts securely.
10. Attach hydraulic hoses (removed in disassembly) to reverse lock valve.
11. Adjust reverse lock valve according to instructions in "Transom Plate Adjustments - Reverse Lock Valve" (see Section 4 "Index").
12. Operate trim system (reverse lock valve in forward or neutral position) to purge air from reverse lock valve.

TRIM CYLINDERS

Removal and Disassembly

NOTE: It is recommended that, when repairing trim cylinders, a new seal kit be used in reassembly or, if inspection determines that internal parts show excessive wear, then a complete overhaul kit should be used.

1. Remove and cap trim cylinder hydraulic lines.
2. Remove nuts from fore and aft anchor pins, then remove trim cylinder. Retain spiral springs, continuity spring washers and rubber bushings for reassembly.
3. While directing cylinder ports toward a container, extend and retract cylinder piston rod (by hand) a number of times to drain oil from cylinder.
4. Place piston rod in soft jawed vise (as close to pivot end as possible). (Figure 3)

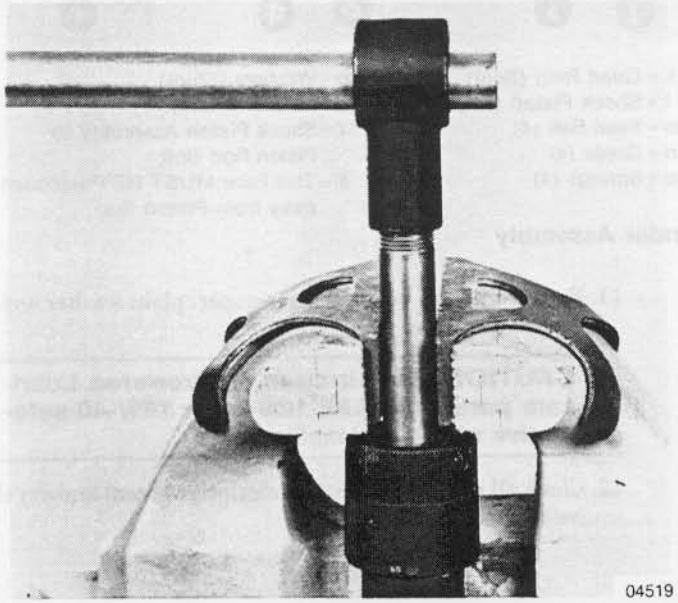


Figure 3. Piston Rod in Vise

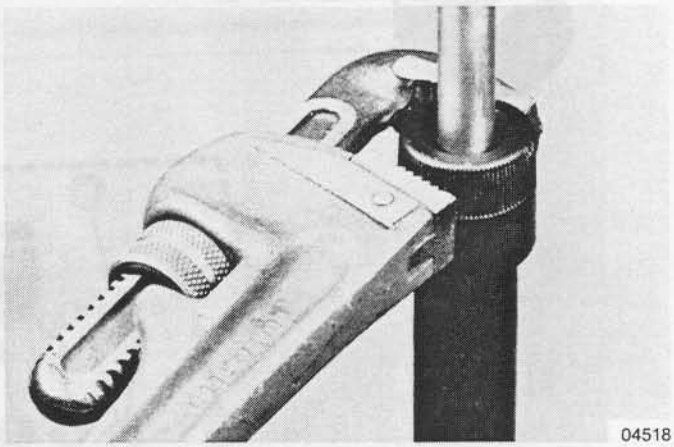
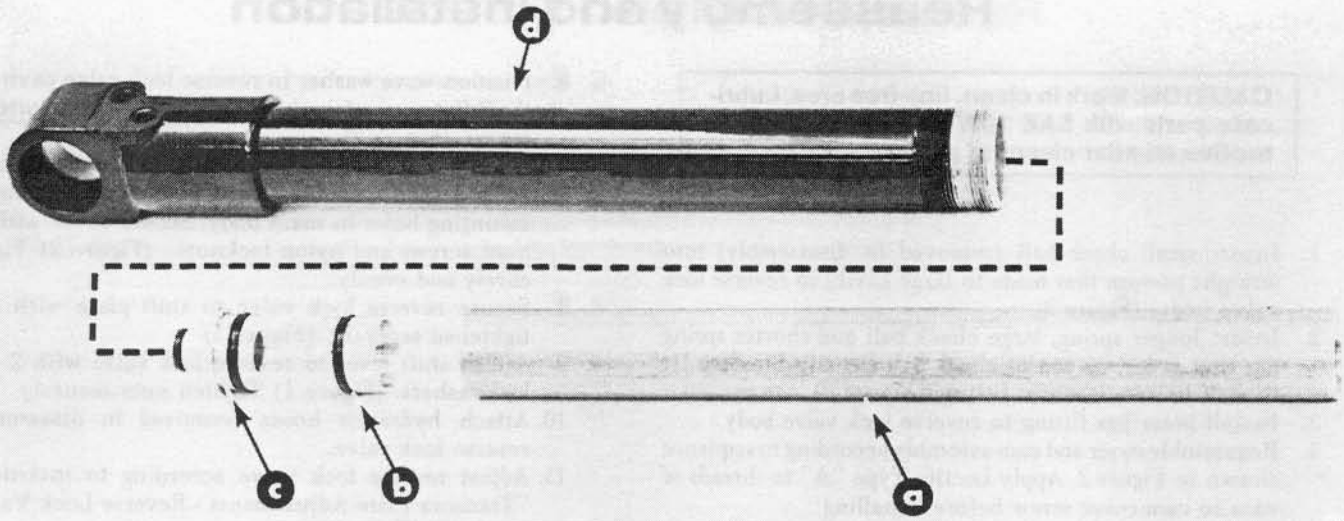


Figure 4. Removing End Cap

5. Place a bar thru eye of pivot and rotate counterclockwise to remove. (Figure 3) If pivot end is extremely tight, apply heat only with piston rod extended, being careful not to overheat cylinder parts.
6. Remove cylinder end cap by turning counterclockwise with a pipe wrench. (Figure 4)
7. Pull piston rod and its components from cylinder. (Inner tube may slide out with it.)
8. Remove inner tube, floating piston and tube guide from outer tube. (Figure 5) Use a wire hook or tap end of tube against a block of wood to remove tube guide, if it remains in outer tube.

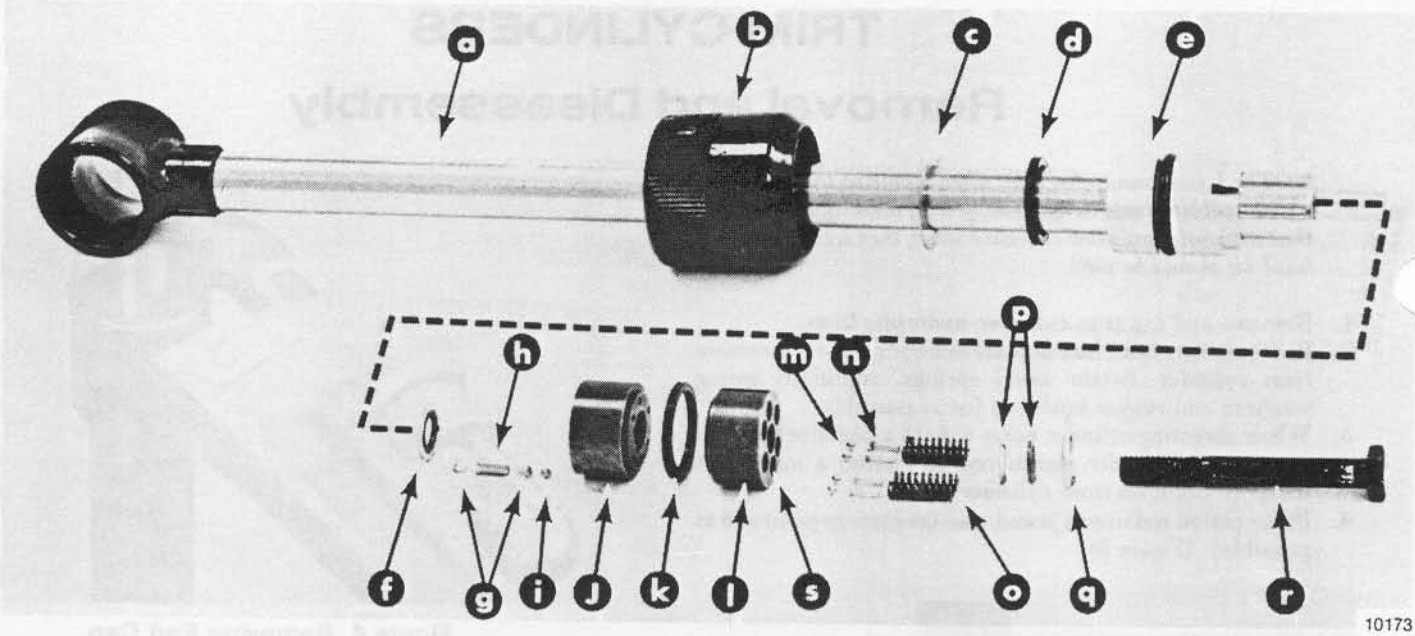
CAUTION: DO NOT clamp vise on sealing surfaces of piston rod.

9. Place piston rod in a soft jawed vise (as close to pivot end as possible) and remove bolt that retains piston assembly. (Figure 6)



a - Inner Tube b - Floating Piston c - Tube Guide d - Outer Tube

Figure 5. Removing Inner Tube



a - Piston Rod
b - Cylinder End Cap
c - Washer (Plain)
d - Scraper
e - Bearing (Piston Rod)
f - Sealing Washer
g - Guide (2)
h - Spring (Bypass-Check)
i - Steel Ball
j - Shock Piston (Return)
k - Quad Ring (Seal)
l - Shock Piston (Impact)
m - Steel Ball (4)
n - Guide (4)
o - Springs (4)
p - Washers (Shim)
q - Washer (Plain)
r - Shock Piston Assembly to Piston Rod Bolt
s - This Face MUST BE Positioned away from Piston Rod

Figure 6. Cylinder Assembly

10. Remove piston assembly from piston rod, being careful to keep all parts of piston in position. (Note that there is a seal washer between piston and piston rod.) (Figure 6)

NOTE: It is recommended that shock piston not be disassembled, however, if disassembly is necessary, be sure that each spring, brass shim and check ball is installed to same hole from which removed.

11. Remove piston rod bearing, scraper, plain washer and end cap from piston rod.

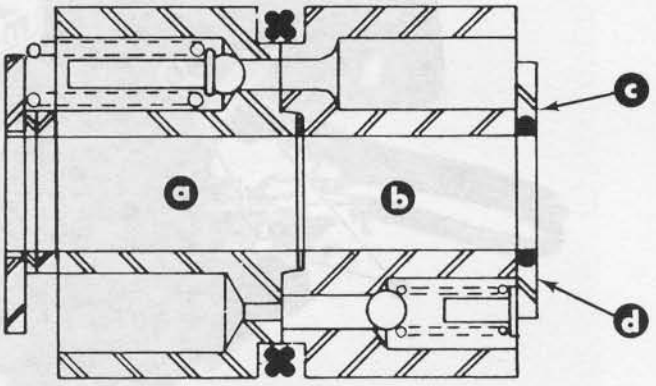
CAUTION: Work in clean, lint-free area. Lubricate parts with SAE 10W-30 or 10W-40 automotive oil after cleaning parts.

12. Clean all parts with suitable cleaning solvent and dry them before reassembly.

Reassembly and Installation

CYLINDER REASSEMBLY

1. Place floating piston (flat diameter toward tube guide) and tube guide (with "O" rings in position) into inner tube, then insert inner tube into outer tube. (Figure 5)
2. Place end cap, plain washer, scraper and piston rod bearing (in that order) onto piston rod. (Figure 6) Be sure that "O" rings are in position on piston rod bearing and that rubber seal is in position over metal scraper.



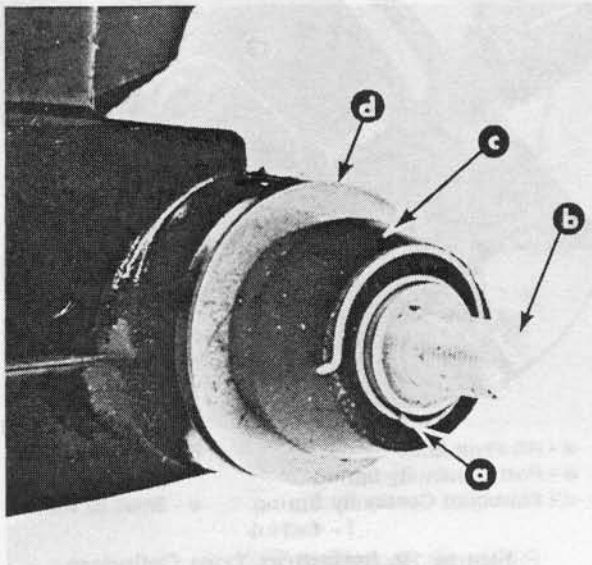
a - Impact Piston (4 Check Balls This Side)
b - Return Piston (One Check Ball This Side)
c - This Side to Piston Rod
d - Sealing Washer

Figure 7. Shock Piston Assembly

3. Carefully inspect piston to ensure that each part is in its correct place (impact piston with male embossment should contain 4 check balls). (Figure 7)
4. Clamp piston rod in soft jaw vise as close to pivot end as possible but not on threads.
5. Install piston assembly so that impact piston (Figure 7) is away from piston rod. Apply Loctite to threads of bolt before installing piston assembly. Also make sure that sealing washer is toward piston rod. (Figure 7) Torque bolt to specifications [20 ft. lbs. (2.77mkg)].
6. Insert piston rod assembly into inner tube and fit piston rod bearing into outer tube.
7. Coat threads of outer tube with Perfect Seal and install end cap. Torque to specifications [35-45 ft. lbs. (4.84-6.22 mkg)].
8. With trim cylinder clamped in soft jaw vise as close to pivot end as possible, apply Loctite to threads and install pivot end. Torque to specifications [25-30 ft. lbs. (3.46-4.15mkg)].
9. Clean and paint over scratches to protect exposed metal.
10. Submerge front end of trim cylinder into SAE 10W-30 or 10W-40 automotive oil. Be sure that capacity of container is larger than trim cylinder requirements, then fully extend and fully retract piston rod a number of times to partially fill cylinder with oil.

CYLINDER INSTALLATION

1. Insert front trim cylnider anchor pin thru hole in gimbal ring and insert aft anchor pin thru hole in drive shaft housing.



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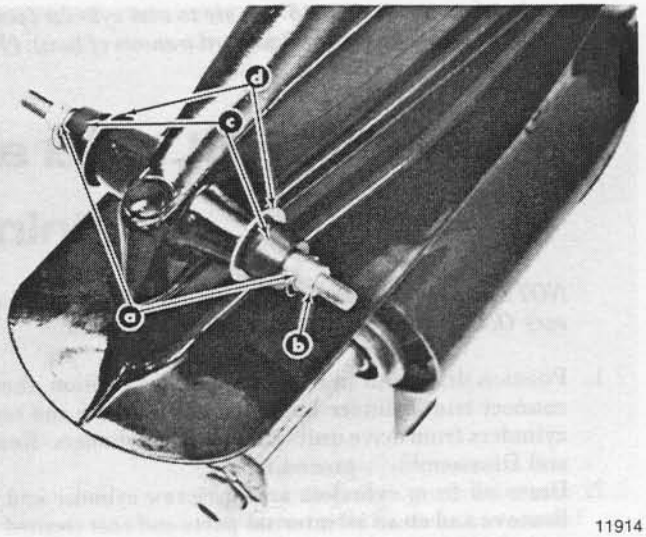
a - Spiral Spring
b - Front Anchor Pin
c - Rubber Bushing
d - Large ID Washer

Figure 8. Front Anchor Pin

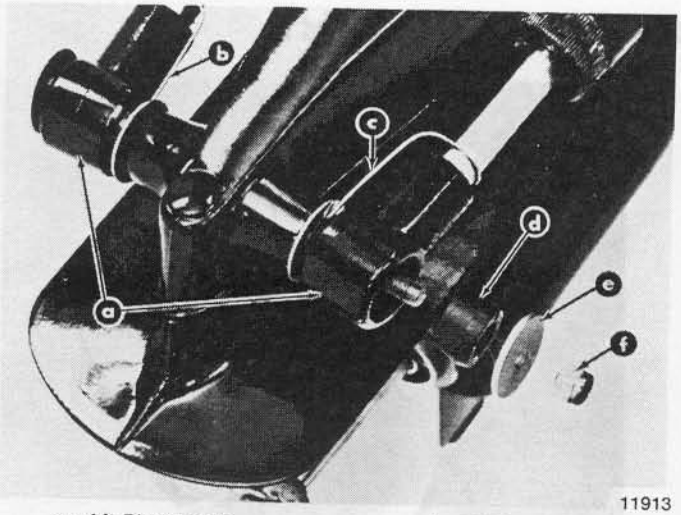


11914

a - Spiral Springs
b - Aft Anchor Pin
c - Rubber Bushings
d - Large ID Washers

Figure 9. Aft Anchor Pin

2. Place large ID flat washer, rubber bushing and spiral grounding spring on each end of both pins, as shown in Figures 8 and 9. Be sure to install rubber bushings with smaller diameter end outward.
3. Install trim cylinders to anchor pins so that connection ports are on top and near front anchor pin.
4. At the aft anchor pin, place long end of continuity spring in-between inner flat washer and rubber bushing, then slide spring forward until it clamps over aft anchor pin. Connect other end of continuity spring to cylinder piston rod (one both sides). (Figure 10)
5. Place rubber bushings (with smaller diameter end inward) and small ID flat washer onto each end of both anchor pins, then coat threads on anchor pins with Universal Joint Lubricant and thread on elastic stop nuts. (Figure 10)



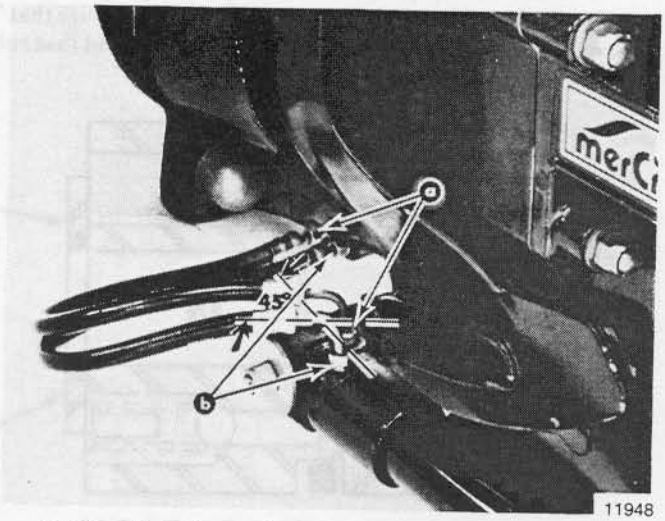
a - Aft Pivot Ends
b - Port Continuity Spring
c - Starboard Continuity Spring
d - Rubber Bushing (One Each Side)
e - Small ID Washer
f - Nut

Figure 10. Installing Trim Cylinders

6. Tighten forward and aft anchor pin nuts until approximately 2 threads are exposed on each nut.

NOTE: Trim hose fittings (cylinder side) should be installed so that fittings are at a 45° angle to trim cylinder (pointing away from gimbal ring and toward transom of boat). (Figure 11)

7. Uncap and install trim hoses to cylinders. Connect aft hose from hydraulic hose connector to aft port on trim cylinder and connect front trim hose to front port on cylinder. (Figure 11)
8. After tightening all fittings securely, operate trim system up-and-down a number of times to purge air from system. If drive unit's action is still "spongy", bleed trim system according to instructions, following.



a - Front Hose Connections
b - Aft Hose Connections

Figure 11. Installing Trim Hoses

DRAINING, FILLING and BLEEDING TRIM SYSTEM

Draining Trim System

NOTE: Complete draining of hydraulic trim system is necessary ONLY if oil in the system is contaminated.

1. Position drive unit in full "down" (in) position, then disconnect trim cylinder hoses at trim cylinder and remove cylinders from drive unit. (See "Trim Cylinders - Removal and Disassembly", preceding.)
2. Drain oil from cylinders and unscrew cylinder end caps. Remove and clean all internal parts and coat cleaned parts with SAE 10W-30 or SAE 10W-40 automotive oil. Reassemble trim cylinders, fill with oil and install cylinders to front anchor pin of stern drive. (See "Trim Cylinders - Removal and Disassembly, Reassembly and Installation", preceding.)
3. Direct trim cylinder hoses into a container and run trim pump in "down" direction until oil stops flowing from trim hoses. Run trim pump in "up" direction until oil stops flowing from trim hoses.
4. Remove trim pump from boat and drain oil from reservoir. Separate valve body and gear assembly from reservoir and drain any remaining fluid from both components. Reassemble pump and install pump into boat. (See "Trim Pump - Removal and Disassembly, Reassembly", preceding.)
5. Proceed with following "Filling and Bleeding" instructions.

Filling and Bleeding Trim System

1. Fill trim pump reservoir to bottom of "Fill" hole threads with SAE 10W-30 or SAE 10W-40 automotive oil.

IMPORTANT: In following instructions, DO NOT allow trim pump reservoir to become low, or air will be induced into the system.

2. With trim hoses disconnected from trim cylinders, run trim pump in "up" direction until a solid stream of oil flows from trim hoses. Repeat procedure running pump in "down" direction.

NOTE: Trim hose cylinder fittings should be installed so that fittings are approximately at a 45° angle to trim cylinder (pointing away from gimbal ring and toward transom of boat). (Figure 12)

3. Retract trim cylinder piston rods, connect "up" hoses and fill pump reservoir. Allow trim cylinders to hang in a vertical position. (Figure 13)
4. Place a rag over "Down" ports of trim cylinders and run pump in "up" direction until cylinder piston rods are fully extended.

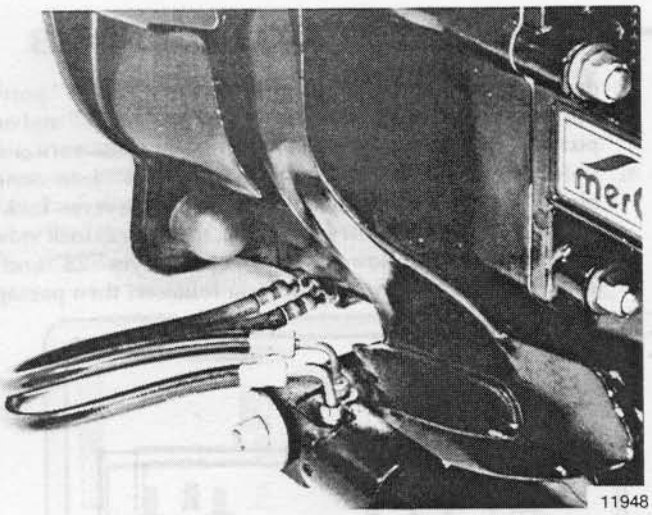
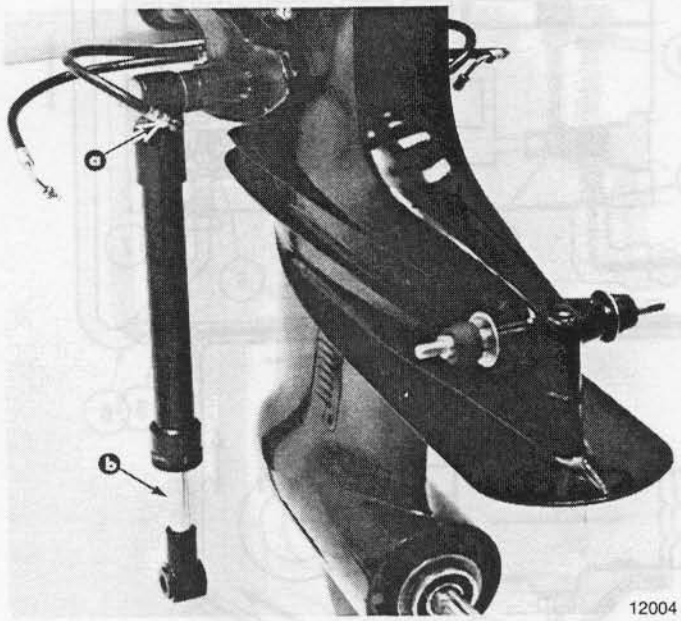


Figure 12. Trim Hoses Installed



a - "Up" Hoses Connected b - Piston Rods Retracted

Figure 13. "Up" Hoses Connected to Trim Cylinders

5. Disconnect "up" hoses and momentarily run pump in "down" direction to clear any air from "down" hoses. Connect "down" hoses to cylinders. (Figure 14)
6. Fill pump reservoir and run pump in "down" direction until cylinder piston rods are fully retracted.
7. Momentarily run pump in "up" direction to clear any air from "up" hoses. Connect "up" hoses to trim cylinders and fill pump reservoir.
8. Run pump in "up" and "down" directions while fully extending and retracting cylinder piston rods a number of times. Install aft end of cylinders to drive unit, being sure that spiral springs and continuity springs (if equipped) are in place. (See "Trim Cylinders - Reassembly and Installation", preceding.)
9. Check fluid level of pump, add oil if needed and install "Fill" screw and tighten securely.

a - "Down" Hoses Connected b - Piston Rods Extended

Figure 14. "Down" Hoses Connected to Trim Cylinders

HYDRAULIC SYSTEM – External Return Lines

HYDRAULIC "UP" CIRCUIT (Figure 1)

When Power Trim pump is activated in the up direction, the motor shaft and gear "1" rotate and draw hydraulic fluid from the pump reservoir "2" thru filter "3" and past check ball "4" in passage below filter. Fluid pressure seats spool "5" and opens check valve "6" allowing fluid to exit pump thru high pressure port "7" into black hydraulic line "8" to connector block "9". Fluid flows from connector block into "up" hydraulic lines "10" and into trim cylinder thru "up" port "11". Fluid exerts pressure against cylinder piston "12" and extend piston rod "13" outward. As piston rod extends outward, fluid is forced thru "down" hydraulic line "14" into connector block, thru gray hydraulic line "15" to reverse lock valve "16". In the neutral-forward mode, the reverse lock valve cam "17" forces cam follower "18" to open valves "23" and "24", allowing fluid to flow around cam follower, thru passage and

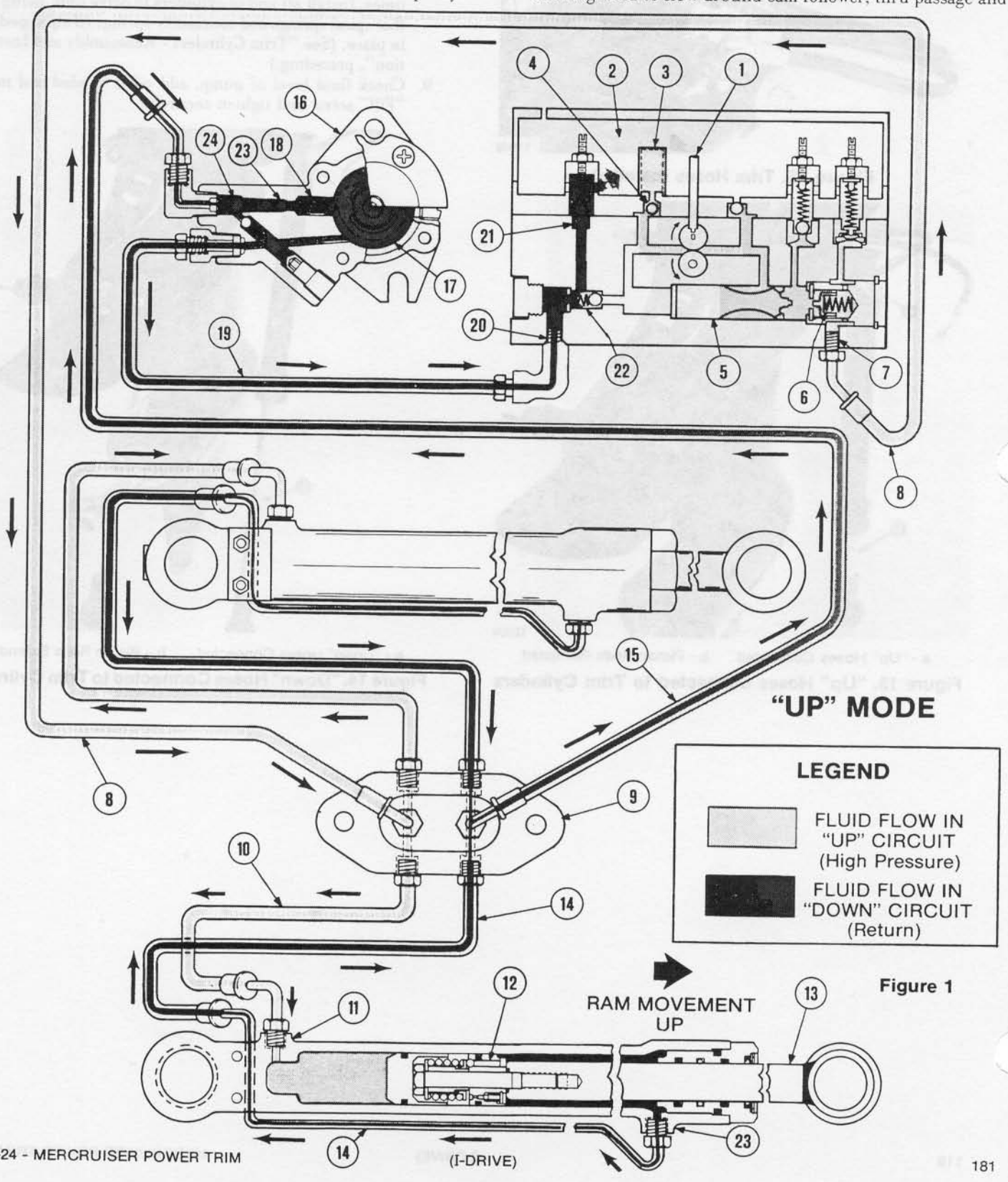


Figure 1

into white plastic hydraulic tubing "19". Fluid flows from reverse lock valve to low pressure port "20" of pump, forcing check ball "21" to unseat, allowing fluid to return to reservoir.

HYDRAULIC "DOWN" CIRCUIT (Figure 2)

When Power Trim pump is activated in down direction, motor shaft and gear draw hydraulic fluid from "up" side of hydraulic circuit. Pressure is created, drawing fluid thru check valve "25". This pressure moves spool "5" which unseats check valve "6" releasing "up" system pressure and allowing fluid to return to pump from "up" circuit. At the same time, check ball "22" is being unseated, allowing fluid to pass thru white plastic hydraulic tubing "19" to reverse lock valve "16". Fluid flows thru reverse lock valve into gray hydraulic line "15", to connector block "9", into "down" (external) trim cylinder line "14" and into trim cylinder thru "down" port "23".

NOTE: See pages 5-4 and 5-5 in this section for flow diagram of hydraulic system when drive unit strikes a submerged object.

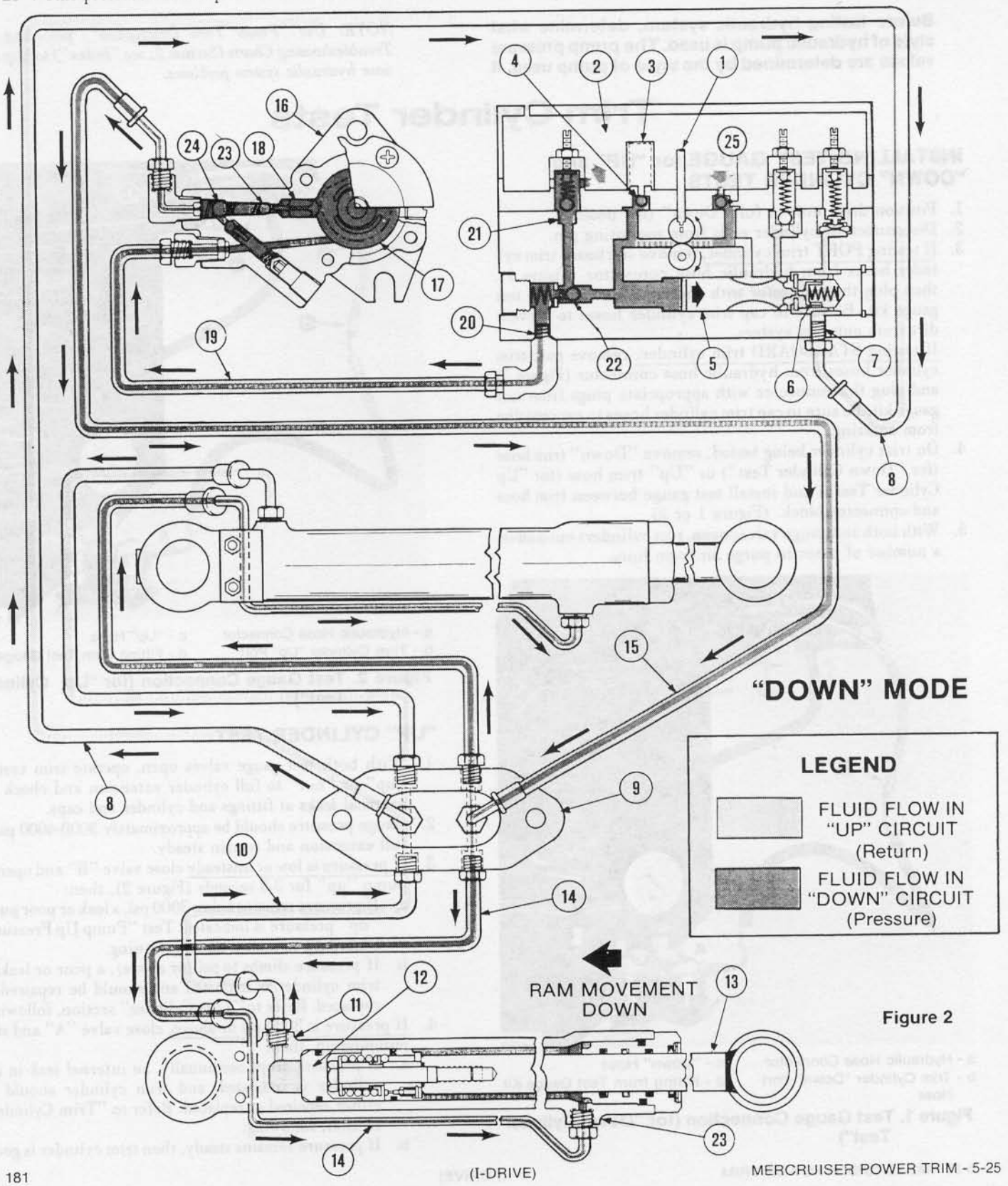


Figure 2

HYDRAULIC SYSTEM TESTING

External Return Lines

IMPORTANT: Hydraulic Test Gauge, C-91-52915A3 must be used in the following procedure. Also, battery must be fully charged BEFORE proceeding with testing, or inaccurate readings may occur.

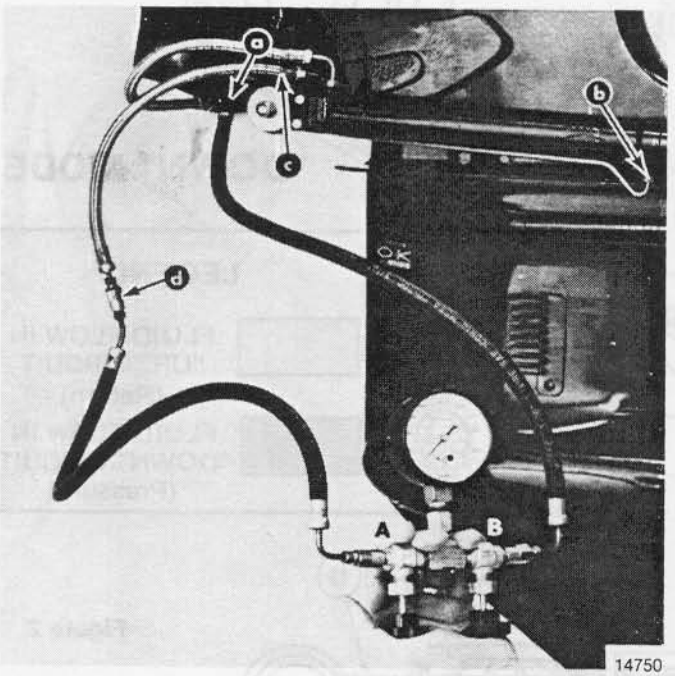
Before testing hydraulic system, determine what style of hydraulic pump is used. The pump pressure values are determined by the style of pump used. It is possible to have a drive unit equipped with an old style pump and new, external line trim cylinders. (See "Power Trim System Identification", preceding.)

NOTE: Use "Power Trim Description", preceding, and Troubleshooting Charts (Section 2; see "Index") to help diagnose hydraulic system problems.

Trim Cylinder Tests

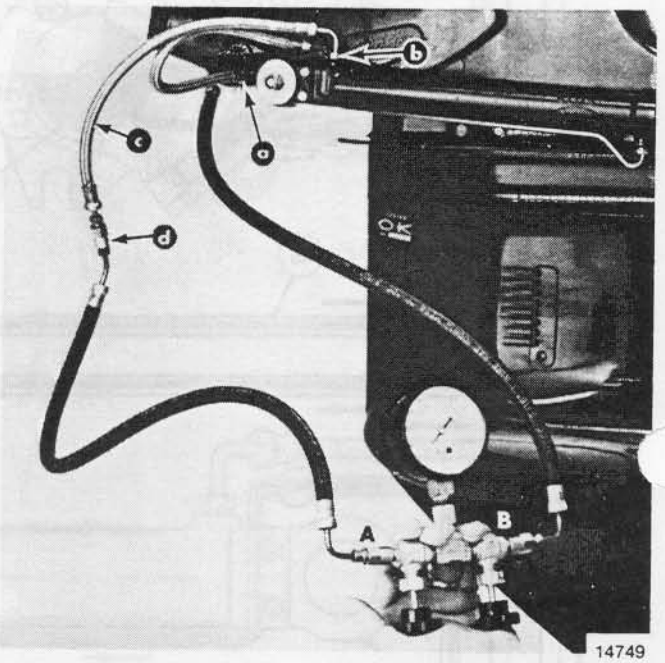
INSTALLING TEST GAUGE for "UP" and "DOWN" CYLINDER TESTS

1. Position drive unit in full "Down" (in) position.
2. Disconnect aft cylinder ends from mounting pin.
3. If testing PORT trim cylinder, remove starboard trim cylinder hoses from hydraulic hose connector (Figure 1), then plug the connector with appropriate plugs from test gauge kit. Be sure to cap trim cylinder hoses to prevent dirt from entering system.
   If testing STARBOARD trim cylinder, remove port trim cylinder hoses from hydraulic hose connector (Figure 2) and plug the connector with appropriate plugs from test gauge kit. Be sure to cap trim cylinder hoses to prevent dirt from entering.
4. On trim cylinder being tested, remove "Down" trim hose (for "Down Cylinder Test") or "Up" trim hose (for "Up Cylinder Test") and install test gauge between trim hose and connector block. (Figure 1 or 2)
5. With both test gauge valves open, run cylinders out-and-in a number of times to purge air from lines.



a - Hydraulic Hose Connector
b - Trim Cylinder "Down" Port Hose
c - "Down" Hose
d - Fitting from Test Gauge Kit

Figure 1. Test Gauge Connection (for "Down Cylinder Test")



a - Hydraulic Hose Connector
b - Trim Cylinder "Up" Port
c - "Up" Hose
d - Fitting from Test Gauge Kit

Figure 2. Test Gauge Connection (for "Up Cylinder Test")

"UP" CYLINDER TEST

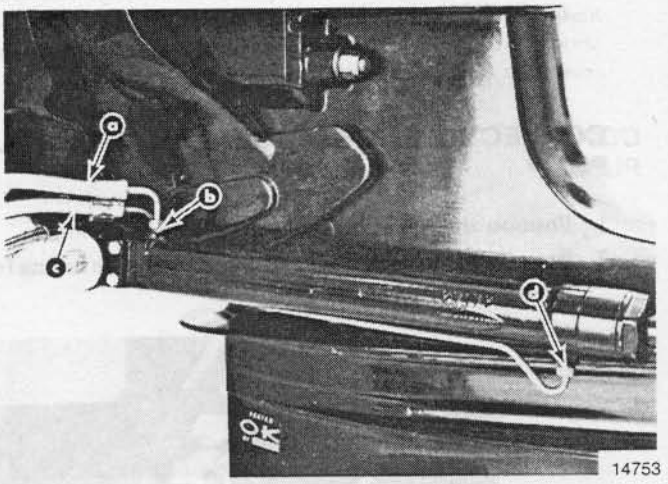
1. With both test gauge valves open, operate trim system "up" or "out" to full cylinder extension and check for external leaks at fittings and cylinder end caps.
2. Gauge pressure should be approximately 3000-4000 psi at full extension and remain steady.
3. If pressure is low or unsteady close valve "B" and operate pump "up" for 3-5 seconds (Figure 2), then:
   a. If pressure remains below 3000 psi, a leak or poor pump "up" pressure is indicated. Test "Pump Up Pressure" according to instructions, following.
   b. If pressure climbs to psi (or above), a poor or leaking trim cylinder is indicated and should be repaired or replaced. Refer to "Trim Cylinder" section, following.
4. If pressure is 3000 psi or above, close valve "A" and stop pumping up, then:
   a. If pressure drops continually, an internal leak in the cylinder is indicated, and trim cylinder should be either repaired or replaced. Refer to "Trim Cylinder" section, following.
   b. If pressure remains steady, then trim cylinder is good.

"DOWN" CYLINDER TEST

1. With test gauge connected between "Down" trim hose and "Down" port on hydraulic hose connector (Figure 1) and both test gauge valves open, operate trim system "down" or "in" to full cylinder retraction and check for external leaks at fittings and cylinder end caps.
2. Gauge pressure should be approximately 650 to 750 psi at full retraction and remain steady.
3. If pressure is low or unsteady, close valve "B" while operating pump "down" (Figure 1), then:
   a. If pressure remains below 650 psi, a poor trail out valve or poor pump "down" pressure is indicated. Test both "Trail Out Valve Pressure" and "Pump Down Pressure" according to instruction, following.
   b. If pressure climbs to 650 psi (or above), a poor trim cylinder is indicated and should be either repaired or replaced. Refer to "Trim Cylinder" section, following.
4. If pressure is 550 psi or above, close valve "A" (Figure 1) and stop pumping "down", then:
   a. If pressure starts to drop, an internal leak in the cylinder is indicated and trim cylinder should be either repaired or replaced. Refer to "Trim Cylinder" section, following.
   b. If pressure remains steady, then trim cylinder is good.

TEST GAUGE REMOVAL

1. If test gauge indicates high pressure, open both test gauge valves. If test gauge still indicates pressure, run pump "down" for an instant.
2. Position drive unit in full "down" (in) position.
3. Remove test gauge hoses from trim hose and trim cylinder and reconnect trim cylinder hose to trim cylinder. Be sure that trim cylinder hose (metal tube end) is at a 45° angle to trim cylinder. (Figure 3)
4. Operate trim system and check for leaks at all connections.



a - "Up" Trim Hose
b - "Up" Port of Trim Cylinder
c - "Down" Hose
d - "Down" Port of Trim Cylinder

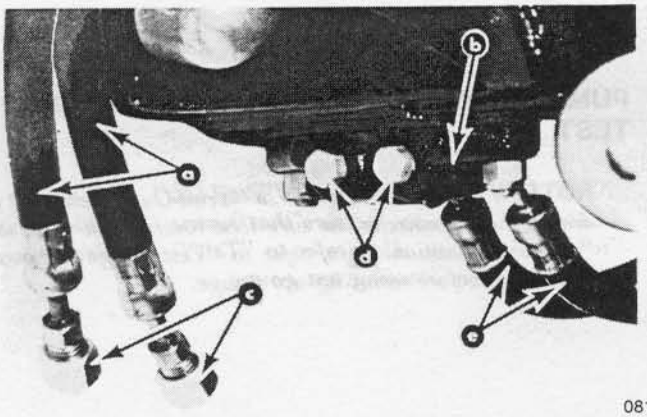
Figure 3. Trim Cylinder Hoses Properly Installed

"Up", "Down" and "Trail-Out" Pressure Tests

Test gauge may be connected to hydraulic system outside boat at hydraulic hose connector (located on bottom of gimbal housing) or inside boat at control valve (located on bottom of trim pump), depending upon accessibility of either location.

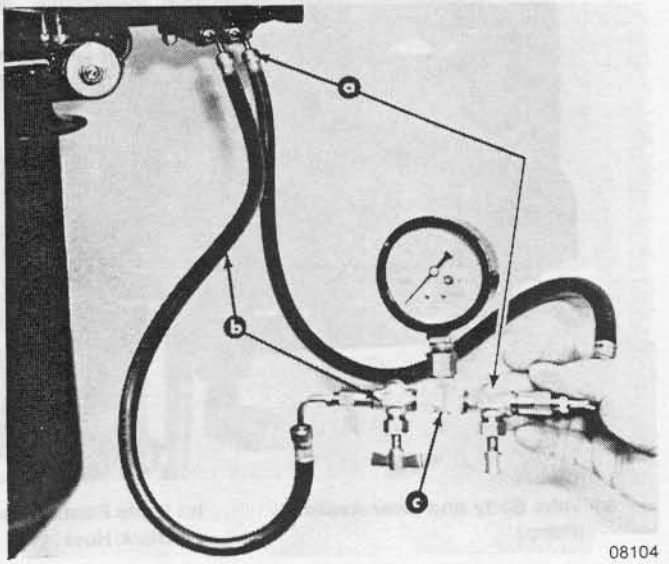
CONNECTING TEST GAUGE to HYDRAULIC HOSE CONNECTOR

1. Position drive unit in full "down" (in) position.
2. Disconnect 4 hydraulic trim cylinder hoses from gimbal housing hydraulic hose connector. (Figure 4)



a - Hoses to Trim Cylinders
b - Hydraulic Hose Connector
c - Hoses Capped (2 Each Side)
d - Plugs
e - Test Gauge Hoses

Figure 4. Hydraulic Hoses Capped



a - "Up" Port Hose and Valve
b - "Down" Port Hose and Valve
c - Test Gauge Assembly

Figure 5. Hydraulic Test Gauge Installed

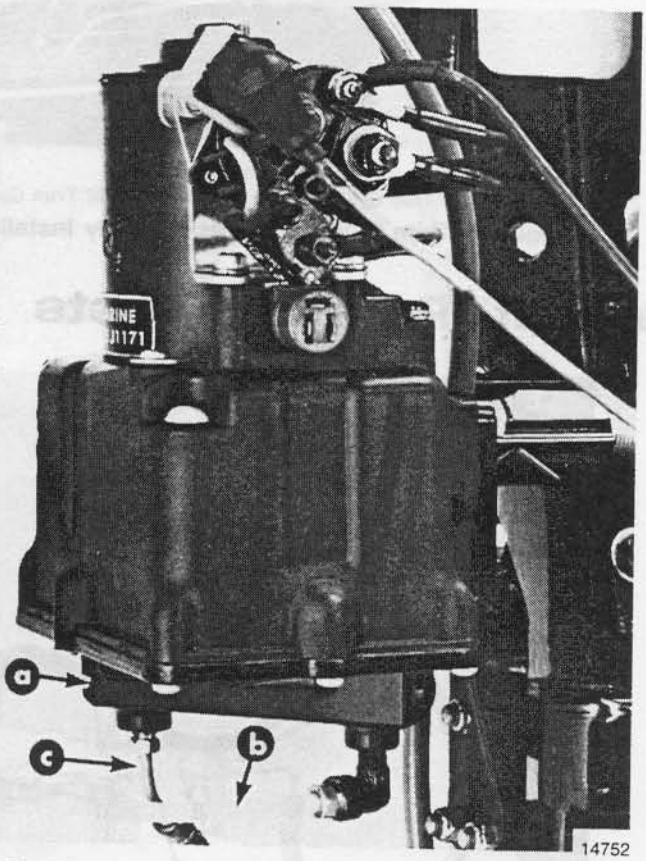
3. Cap off all 4 hoses.
4. Plug hose connections on one side of hose connector. (Figure 4)
5. Install test gauge hose to hose connections on other side of connector. (Figure 5) Be sure that all hose connections and plugs are tightened securely and do not leak.

6. Check pump oil level. If oil level is below fill screw threads in reservoir, add needed amount of SAE 10W-30 or 10W-40 automotive oil.
7. With both test gauge valves open, run pump "up" and "down" a number of times to purge air from lines.

NOTE: Test gauge hose, that is connected to front of hydraulic hose connector, will be referred to as, "Up" port hose and valve. Test gauge hose, that is connected to aft hose connection, will be referred to as "Down" port hose and valve. (Figure 5) Also, when test gauge is connected at hose connector, reverse lock valve should be in "forward" position.

CONNECTING TEST GAUGE TO HYDRAULIC PUMP

1. Position drive unit in full "down" (in) position.
2. Remove and cap black hose and white plastic tubing from control valve. (Figure 6)



a - Valve Body and Gear Assembly (Pump)
b - White Plastic Tubing
c - Black Hose

Figure 6. Trim Pump

3. Connect test gauge hoses to control valve assembly, as shown in Figure 7, using adaptor from test gauge kit for "Down" port connection.
4. Check pump oil level. If oil level is below fill screw threa in reservoir, add needed amount of SAE 10W-30 or 10W-40.
5. With both test gauge valves open, run pump "up" and "down" a number of times to purge air from lines.

NOTE: Test gauge hose, that is connected to "Up" port, will be referred to as "Up" port hose and valve. Test gauge hose, that is connected to "Down" port, will be referred to as "Down" port hose and valve. (Figure 7)

PUMP "UP" PRESSURE TEST

NOTE: Refer to "Test Gauge Removal", following, before removing test gauge.

1. Close "Down" port valve and open "Up" port valve (Figure 5)
2. Run pump in "up" direction until pressure stops rising, as indicated on gauge. Pump output "Up" pressure should be a minimum of 3000 psi.
3. Stop pumping "up". Gauge pressure should drop slightly, then hold steady.
4. If gauge indicates "low pressure" or "low pressure and does not hold steady":
   a. Check for leaks at all connections. Tighten or replace hoses, if necessary.
   b. If step (a) does not remedy problem, a poor check valve (inside pump) is indicated, and replacement of valve body and gear assembly is required. Refer to "Hydraulic Pump" section, following.

NOTE: If a faulty valve body and gear assembly is suspected, repeat Steps 1-thru-4, above, a few times to be sure that the cause is not just a piece of foreign material lodged under the check balls, resulting in "leak down". Repeating the test can sometimes "purge" the particle and eliminate the leak.

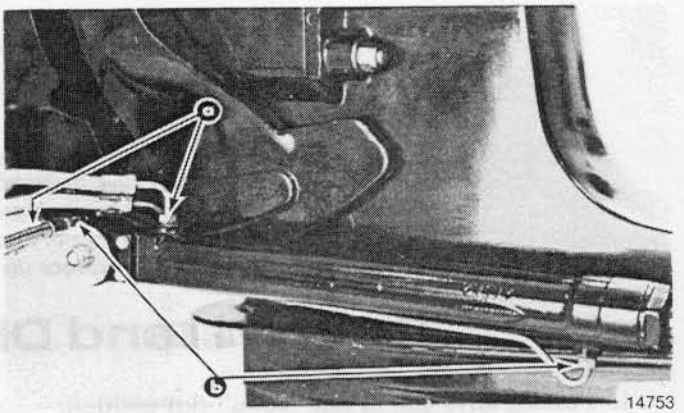
PUMP "DOWN" and "TRAIL-OUT" PRESSURE TEST

NOTE: If testing the "Down" or "Trail-Out" pressure at hydraulic hose connector, be sure that reverse lock valve is in "forward" position. Also, refer to "Test Gauge Removal", following, before removing test gauge.

1. Open "Down" port valve and close "Up" port valve. (Figure 5)
2. Run pump in "Down" direction and note gauge reading. Reading should be approximately 650 to 750 psi.
3. Stop pumping "down". Pressure should drop slowly and may possibly become steady around 100 psi (7kg/cm²) or drop to zero psi.
4. If gauge indicates less than 500 psi while pumping down:
   a. Check for leaks at all connections. Tighten or replace hoses and/or fittings, if necessary.
   b. Check reverse lock valve for leaks around top cover. Replace "O" ring, if necessary.
   c. If (a) or (b) do not remedy problem, then a poor check valve in valve body is indicated, and replacement of valve body and gear assembly (Figure 6) is necessary. Refer to "Hydraulic Pump" section, following.

REMOVING TEST GAUGE from HYDRAULIC HOSE CONNECTOR

1. If test gauge indicates high pressure, open both "Down" port and "Up" port valves. If test gauge still indicates pressure, run pump "down" for an instant.
2. Remove test gauge hoses and plugs from hydraulic hose connector.
3. Remove caps from hydraulic trim cylinder hoses.
4. Install aft trim cylinder hoses to aft hose connections on hydraulic connector. (Figure 7)
5. Install front trim cylinder hose to front hose connections on connector. (Figure 7)
6. Operate trim system and check for leaks at all connections.



a - Front Hose Connections b - Aft Hose Connections

Figure 7. Connecting Trim Hoses

REMOVING TEST GAUGE from HYDRAULIC PUMP

1. If test gauge indicates high pressure, open both "Down" port and "Up" port valves. If test gauge still indicates pressure, run pump "down" for an instant.
2. Remove test gauge hoses from pump.
3. Uncap and install black hydraulic hose to "Up" port on control valve. (Figure 6)
4. Uncap and install clear plastic hose to "Down" port on control valve. (Figure 6)
5. Operate trim system and check for leaks at all connections.

NOTE: See page 5-10 in this section for Reverse Lock Valve Test.

Reverse Lock Valve Test

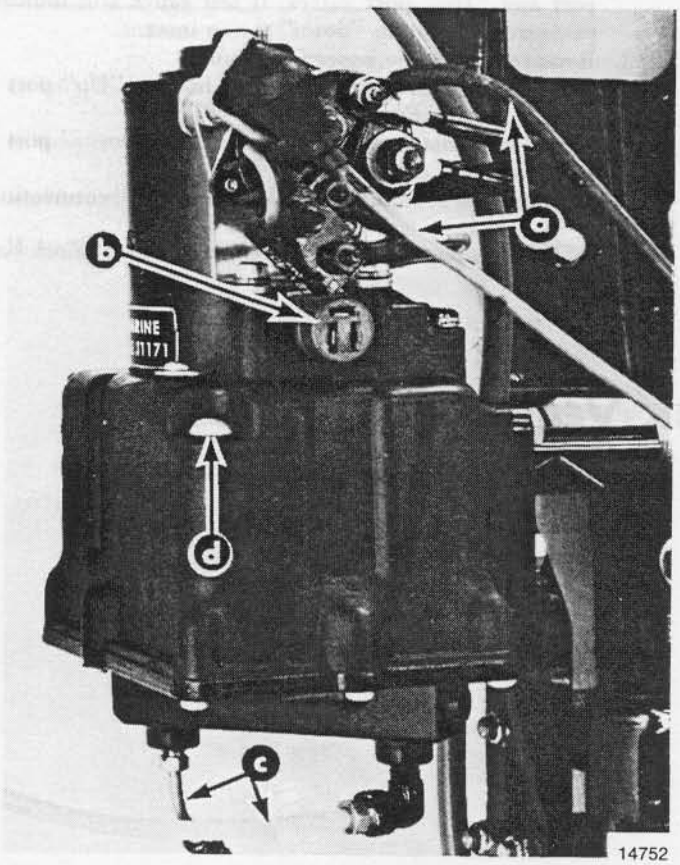
Refer to "Reverse Lock Valve Test (All Styles)", Preceding.

HYDRAULIC TRIM PUMP
Internal Control Valve

NOTE: The following instructions are for complete disassembly and reassembly of pump. In many cases, however, complete disassembly of pump is not required and, in those cases, it is necessary only to perform the operations which are required to replace the faulty part.

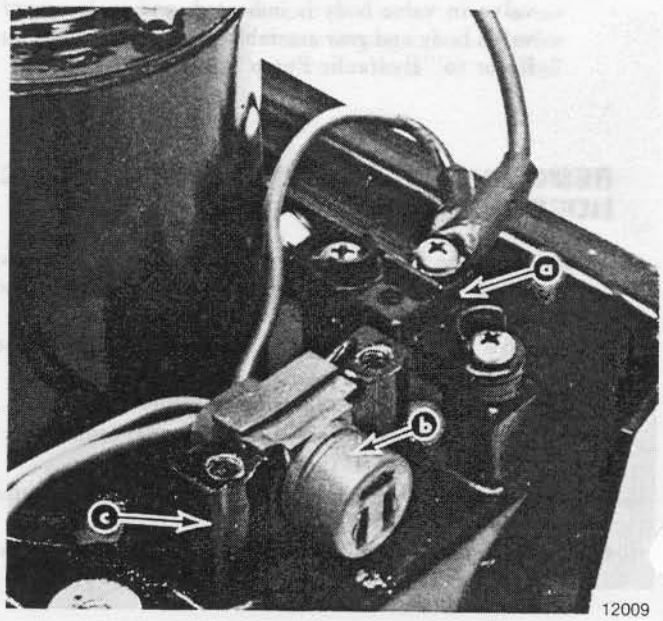
Removal and Disassembly (Figure 1)

1. Position drive unit in full "down" (in) position.
2. Disconnect trim pump battery leads from battery, remove other end of black wire from solenoid and remove other end of red wire from fuse.
3. Disconnect trim control harness from trim pump.
4. Disconnect hydraulic hoses from bottom of pump. Cap hoses and plug hose connections.
5. Remove pump from mounting bracket on V-8 configuration or from transom plate on In-Line configuration.



a - Battery Leads
b - Trim Control Harness Plug
c - Hydraulic Hoses
d - Fill Screw

Figure 1. Hydraulic Trim Pump



a - Terminal Block (if Equipped)
b - Harness Connector
c - Reservoir

Figure 2. Removing Harness Connector

6. Remove "Fill" screw (Figure 1) and drain oil.
7. Remove 8 screws, which secure valve body to reservoir, and separate valve body from reservoir. (Figure 3)
8. Disconnect motor leads from solenoids (or solenoid) and terminal block (if equipped).
9. Remove solenoid (or solenoids) from mounting bracket and remove mounting bracket from pump.
10. Remove harness connector and terminal block (if equipped) from reservoir. (Figure 2)
11. Remove 2 long screws, which secure pump motor to reservoir, and separate field frame from reservoir. Be careful not to lose ball located on end of armature shaft. (Figure 1)
12. Remove armature from reservoir and remove 2 washers from armature shaft. (Figure 3)
13. Separate commutator end plate from pump. Be sure not to lose brush springs. (Figure 3)

Electrical Testing

Refer to "Electrical Testing (All Styles)", Preceding.

Reassembly

CAUTION: Work in clean, lint-free area. Lubricate parts with SAE 10W-30 or 10W-40 automotive oil after cleaning parts.

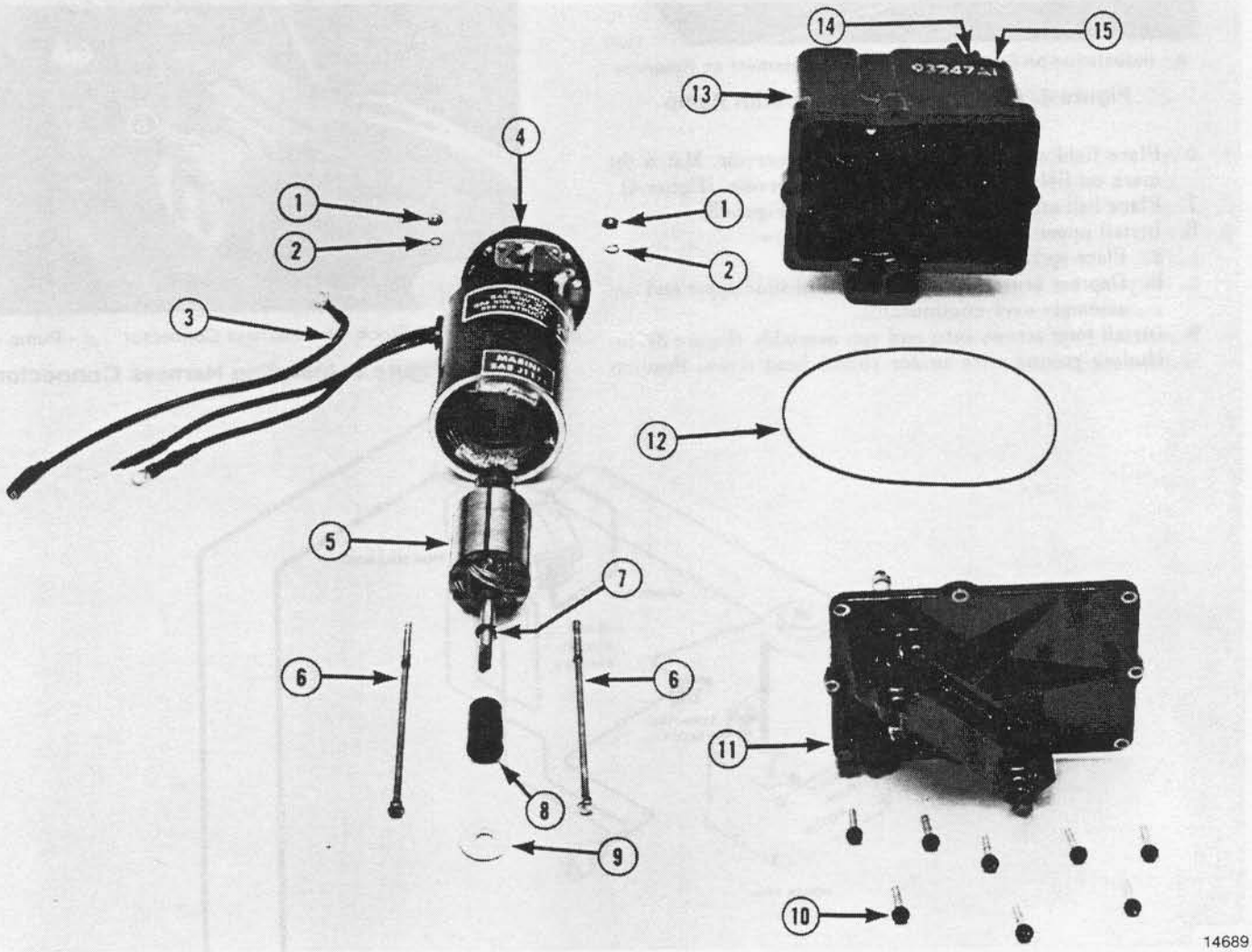
1. Place small amount of Liquid Neoprene (C-92-25711) in seal groove of valve body and gear assembly to hold seal in position during installation.

CAUTION: DO NOT use Liquid Neoprene in excess or allow it to enter valve and gear assembly.

2. Install new seal on valve body and gear assembly.
3. Install valve body and gear assembly to reservoir with 8 screws and tighten evenly.
4. Place washer on bottom of armature shaft. (Figure 3) Insert armature into reservoir, being sure that it engages into pump gears.

CAUTION: Solder, that is used to install new brushes, must be rosin core and have a melting point above 350°F (177°C). Use a soldering gun to solder. DO NOT use a torch.

5. If testing determines that brushes should be replaced, replace brushes as follows:
   a. Cut old brush shunt at point where brush is connected to end cap.
   b. Solder new brush shunt to connection point, using rosin core solder 40-60 tin-lead alloy or equivalent rosin core solder that has a melting point above 350°F. DO NOT use acid core solder, because of corrosive action of acid.



1. Nut, Thru Bolt (2)
2. Lockwasher, Thru Bolt (2)
3. Wire, Pump to Solenoid
4. End Cap Assembly
5. Armature
6. Thru Bolt (2)
7. Washer, Armature Shaft
8. Coupler, Armature Shaft to Valve Body Assembly
9. Washer, Coupler to Pump Reservoir
10. Screw, Valve Body to Reservoir (8)
11. Valve Body Assembly
12. Gasket, Valve Body to Reservoir
13. Reservoir
14. Screw, Vent (Hidden)
15. Screw, Fill (Hidden)

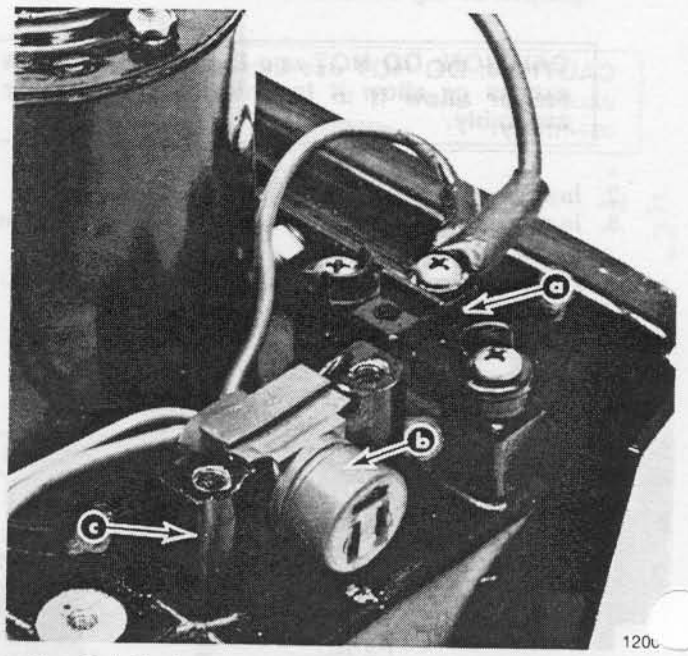
Figure 3. Trim Pump Assembly (Plastic Body)

NOTE: See Page 5-14 in this section for Hydraulic Pump electrical components.

a - Indentation on Field Frame b - Embossment on Reservoir

Figure 4. Alignment Marks on Trim Pump

6. Place field and frame assembly on reservoir. Match the mark on field frame with mark or reservoir. (Figure 4)
7. Place ball on top of armature shaft. (Figure 3)
8. Install upper end cap assembly as follows:
   a. Place springs in brush holders.
   b. Depress brushes into holders and slide upper end cap assembly over commutator.
9. Install long screws into end cap assembly (Figure 3), including ground wire under round head screw. Position round head screw (through end cap) on side of trim pump in location shown in Figure 3.
10. Place harness connector in groove on reservoir body a install terminal block, if so equipped. (Figure 5)
11. Install solenoid(s) to bracket, then install solenoid mounting bracket to reservoir body and the pump motor thru bolt. (Figure 3)
12. Install fuse and circuit breaker (Figure 3) and make wire connections as shown in Figures 6, 7, 8 or 9. DO NOT connect battery at this time.



a - Terminal Block b - Harness Connector c - Pump Reservoir

Figure 5. Installing Harness Connector

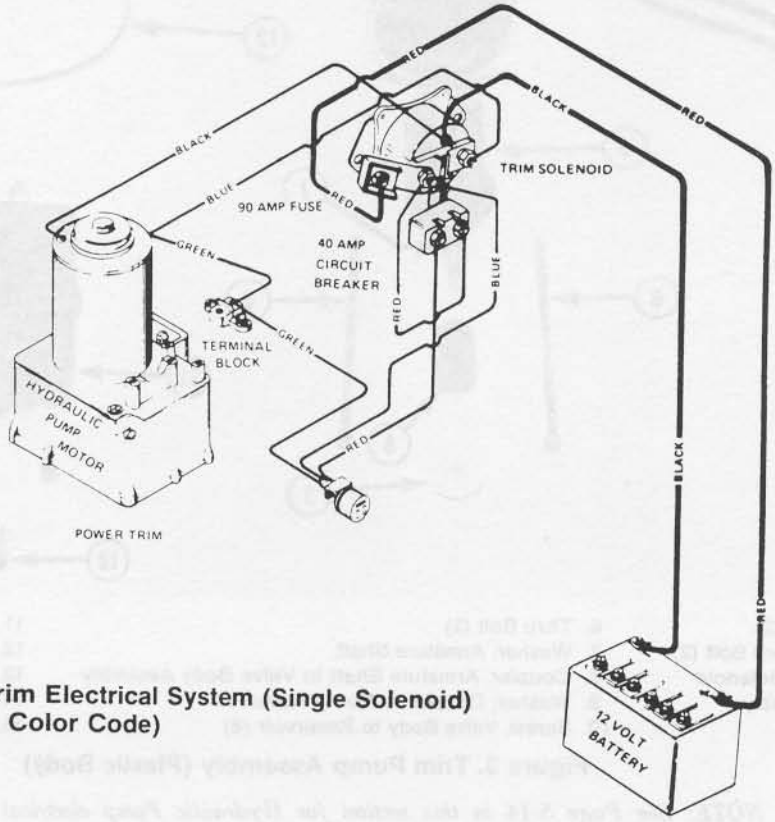


Figure 6. Power Trim Electrical System (Single Solenoid) (Pre-BIA Color Code)

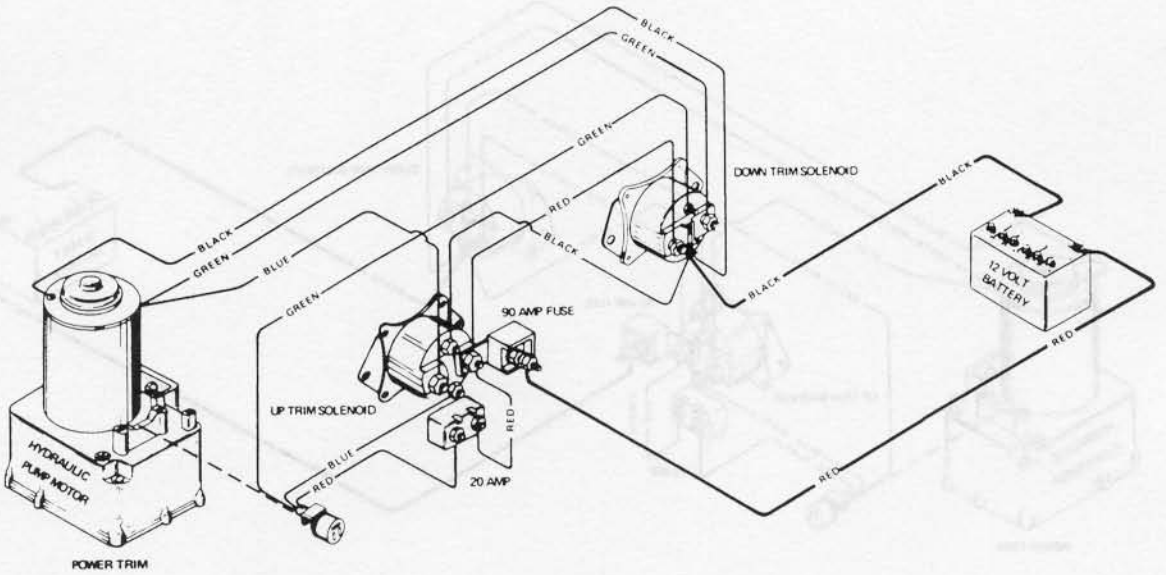


Figure 7. Power Trim Electrical System (Dual Solenoid) (Pre-BIA Color Code)

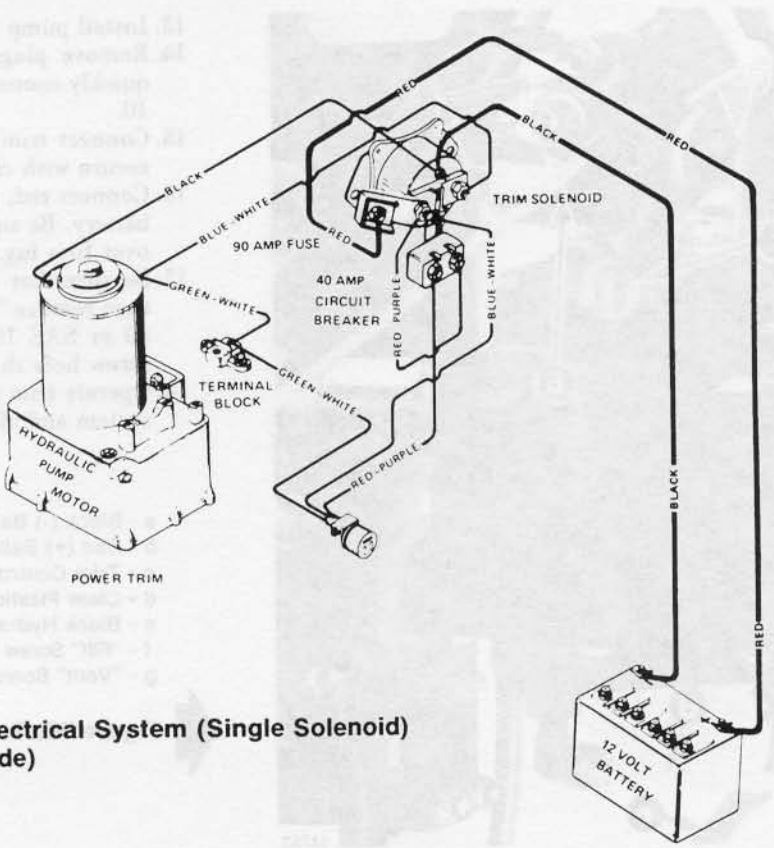


Figure 8. Power Trim Electrical System (Single Solenoid) (BIA Color Code)

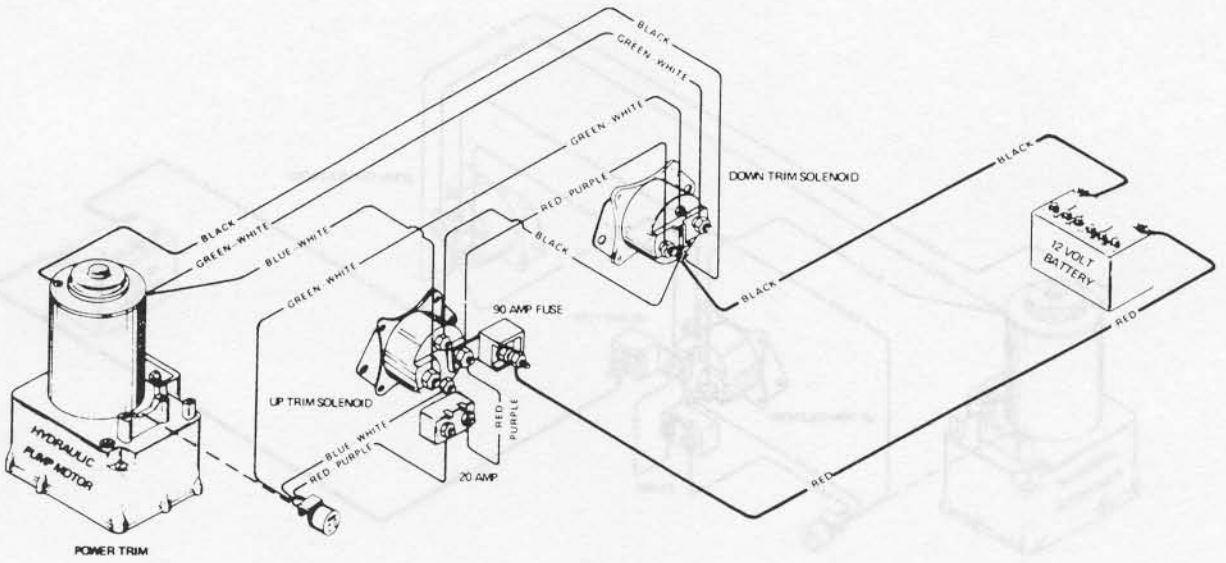
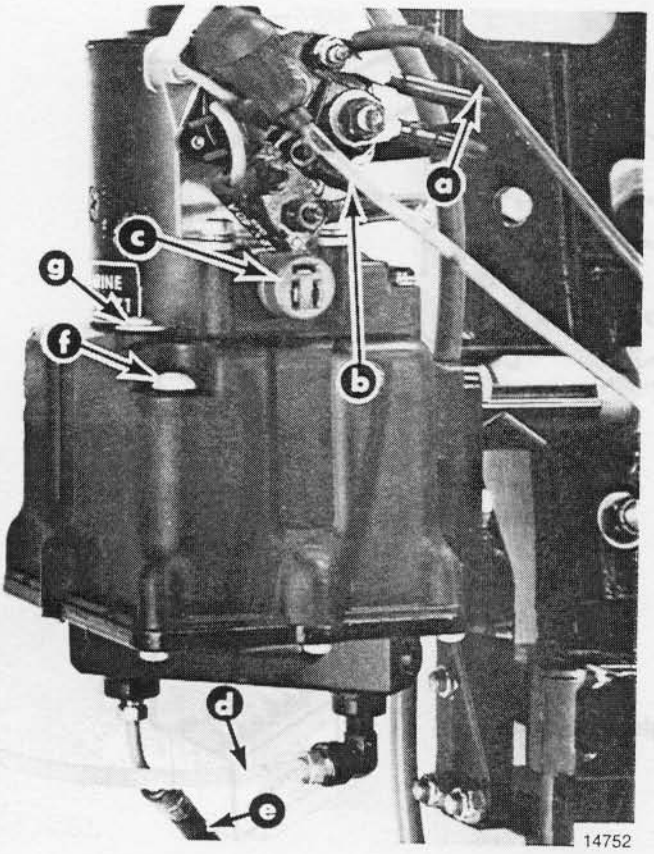


Figure 9. Power Trim Electrical System (Dual Solenoid) (BIA Color Code)



13. Install pump to mounting bracket.
14. Remove plugs from pump, uncap hydraulic hoses and quickly connect hoses to control valve, as shown in Figure 10.
15. Connect trim control harness to harness connector and secure with clamp. (Figure 10)
16. Connect red, then black, battery lead from trim pump to battery. Be sure that rubber boot on red wire is in place over fuse lug. (Figure 10)
17. Be sure that "Vent" screw (Figure 10) is open 2 turns, then remove "Fill" screw and fill reservoir with SAE 10W-30 or SAE 10W-40 automotive oil to bottom of "Fill" screw hole threads. Reinstall "Fill" screw.
18. Operate trim system a number of times to purge air from system and also to check for correct operation.

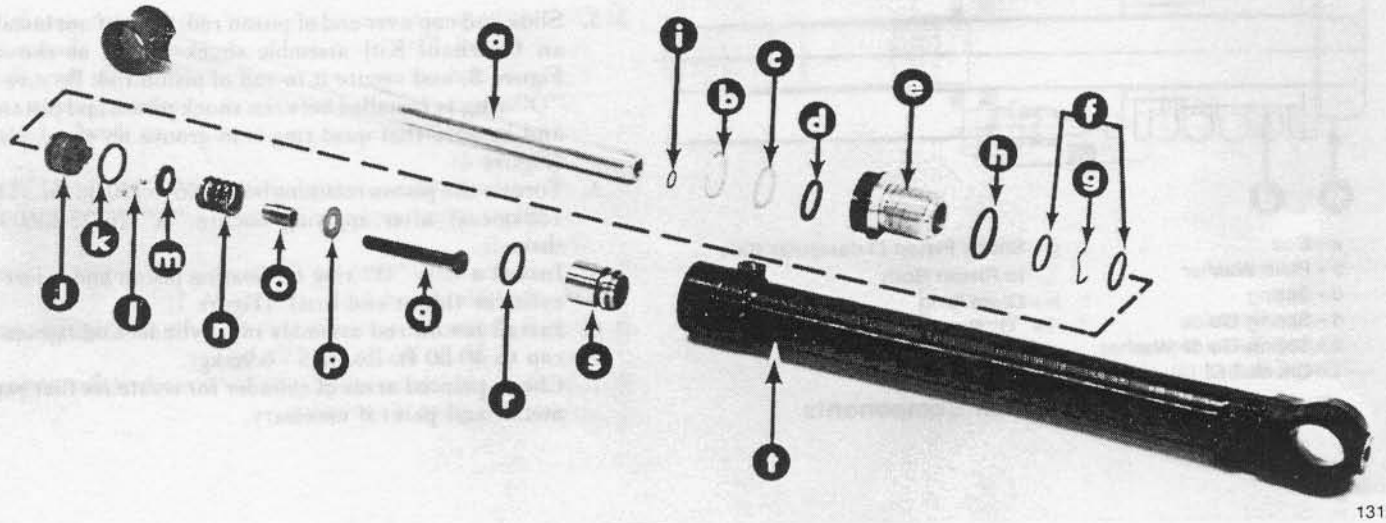
a - Black (-) Battery Lead
b - Red (+) Battery Lead
c - Trim Control Harness Plug
d - Clear Plastic Hose
e - Black Hydraulic Hose
f - "Fill" Screw
g - "Vent" Screw

Figure 10. Trim Pump Installed

TRIM CYLINDERS (EXTERNAL RETURN LINE)
Removal and Disassembly

NOTE: It is recommended that when repairing trim cylinders, a new seal kit be used in reassembly, or if inspection of parts show excessive wear, a complete overhaul kit be used.

1. Remove trim cylinder hydraulic lines from hydraulic connector. Plug connector outlets and cap ends of hydraulic lines.
2. Remove nuts securing trim cylinders to fore and aft anchor pins, then remove trim cylinders.
3. If outer cylinder is to be replaced, remove trim cylinder hose clamping plates, then remove external hydraulic hose and line. Plug "down" port of trim cylinder.
4. Remove hydraulic hose caps (or "down" port plugs, if lines have been removed in Step 3) and direct line toward a container. Extend and retract cylinder piston rod (by hand) several times to purge oil from cylinder.
5. Unscrew hex head cylinder end cap from cylinder tube (Figure 1) and pull piston rod from tube.

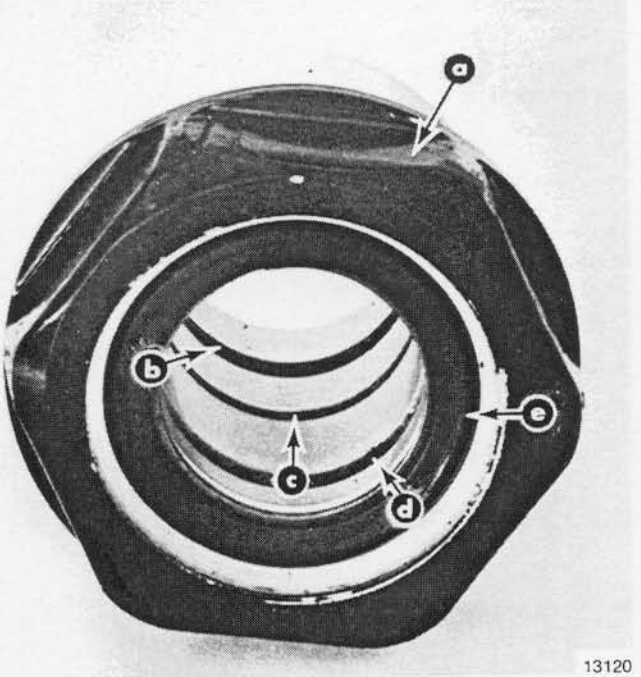


13125

a - Piston Rod
b - Retaining Ring
c - Plain Washer
d - Rod Scraper
e - Cylinder End Cap
f - "O" Ring (Internal), 2-Piece
g - Continuity Spring
h - "O" Ring (End Cap)
i - Small "O" Ring
j - Shock Piston
k - Quad Ring (Seal)
l - Check Balls (3)
m - Spring Guide Washer
n - Spring
o - Spring Guide
p - Plain Washer
q - Bolt
r - "O" Ring
s - Floating Piston
t - Cylinder

Figure 1. Trim Cylinder Component Parts

6. Remove floating piston (Figure 1) from cylinder. It may be necessary to tap the open end of cylinder on a block of wood. Remove and discard "O" ring.
7. Remove piston assembly from end of piston rod (be careful not to lose check balls), then remove and discard "O" ring and quad ring seal. If installing Overhaul Kit, discard piston assembly.
8. Remove end cap from piston rod and remove retaining ring, plain washer and scraper. Remove 2 "O" rings and continuity ring from inside end cap. Discard everything but the end cap.
9. Clean all parts in a non-toxic solvent. After cleaning, be sure that all parts are dry before reassembling.



13120

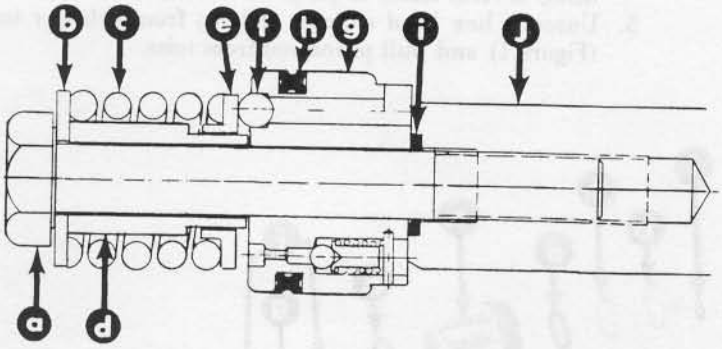
a - End Cap
b - "O" Ring Groove
c - Continuity Ring Groove
d - "O" Ring Groove
e - Scraper

Figure 2. End Cap Components

REASSEMBLY

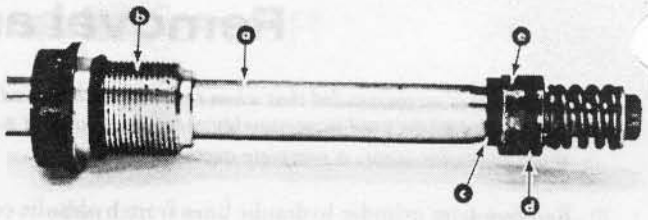
NOTE: Before reassembly, lubricate all internal parts with SAE10W-30 or 10W-40 motor oil.

1. Place new rod scraper into end of end cap (Figure 2), then secure with new plain washer and retaining ring.
2. Install continuity ring into middle groove and both "O" rings in outermost grooves inside end cap. Install large "O" ring on outside of end cap. (Figure 2)



a - Bolt
b - Plain Washer
c - Spring
d - Spring Guide
e - Spring Guide Washer
f - Check Ball (3)
g - Shock Piston (Triangular Side to Piston Rod)
h - Quad Ring
i - "O" Ring
j - Piston Rod

Figure 3. Shock Piston Components



13123

a - Piston Rod
b - End Cap
c - "O" Ring
d - Quad Ring
e - Shock Piston

Figure 4. Securing Shock Piston to Piston Rod

3. Slide end cap over end of piston rod, then [if not installing an Overhaul Kit] assemble shock piston, as shown in Figure 3, and secure it to end of piston rod. Be sure that "O" ring is installed between shock piston and piston rod and be sure that quad ring is in groove on shock piston. (Figure 4)
4. Torque the piston retaining bolt to 96 to 120 in. lbs. (111 to 138kg-cm) after applying Loctite "A" (C-92-32609) to threads.
5. Install a new "O" ring on floating piston and insert into cylinder (blunt end first). (Figure 1)
6. Install piston rod assembly into cylinder and tighten end cap to 40-50 ft. lbs. (5.5 - 6.9mkg).
7. Check painted areas of cylinder for scratches that expose metal, and paint if necessary.

DUAL TRIM TEST (All Styles)

IMPORTANT: In the following tests, control box harness connectors must be disconnected and key switch must be turned to "Off" position. Also, make certain that the jumper lead (between 3 and 5) is used only when specified. The tests listed following, are in sequence according to probability of component failure. However, it is recommended that all tests be performed even if a faulty component is detected early in the sequence. This precaution will guard against repeat failure if there is more than one failed component.

CAUTION: Terminals 2 and 3 carry 12 volts at all times, therefore, when using a VOA meter, be careful when testing in or near this area of the control box. A short could cause possible damage to the control box and/or VOA meter.

RELAY #1

a. Test for 12 volts at 2 with reference to 4: if voltage is not shown, replace relay.
b. Connect a jumper between 3 and 5, then check for 12 volts at 2 with reference to 4: if voltage is shown, replace relay.

RELAY #2

a. Test for continuity between 13 and 9: if no continuity is shown then replace relay.
b. Connect a jumper between 3 and 5 then test for continuity between 13 and 9: if continuity is shown, then replace relay.

IMPORTANT: "Diode Test" (mentioned following) refers to connecting one lead of an ohmmeter (set on R x 1 scale) to one of the two terminals mentioned and the other lead to the other terminal. Note reading then reverse test leads and again note reading. If diode is good, meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading (below 60 ohms) when connected the other. If both readings are high or infinite (diode is open) or if both readings are low (diode is shorted), replace diode pack.

DIODE #1: Connect a jumper between 3 and 5 then perform diode test between terminal #9 and #10.

DIODE #2: Connect a jumper between 3 and 5 then perform diode test between terminal #10 and #13.

IMPORTANT: After this point in the "Diode Pack" test, remove fuse from red/purple lead so that it will not be possible to short either the control box or VOA meter.

DIODE #3: Perform diode test between terminal #6 and #12.

DIODE #4: Perform diode test between terminal #12 and #7.

DIODE #5: Perform diode test between terminal #8 and #11.

DIODE #6: Perform diode test between terminal #14 and 15.

DIODE #7: Perform diode test between terminal #8 and #15.

DIODE #8: Perform diode test between terminal #5 and #15.

TRAILER SWITCH

CAUTION: Fuse must be removed for following test.

a. Push switch down - check for continuity between 10 and 3.
b. Push switch up - check for continuity between 2 and 12.

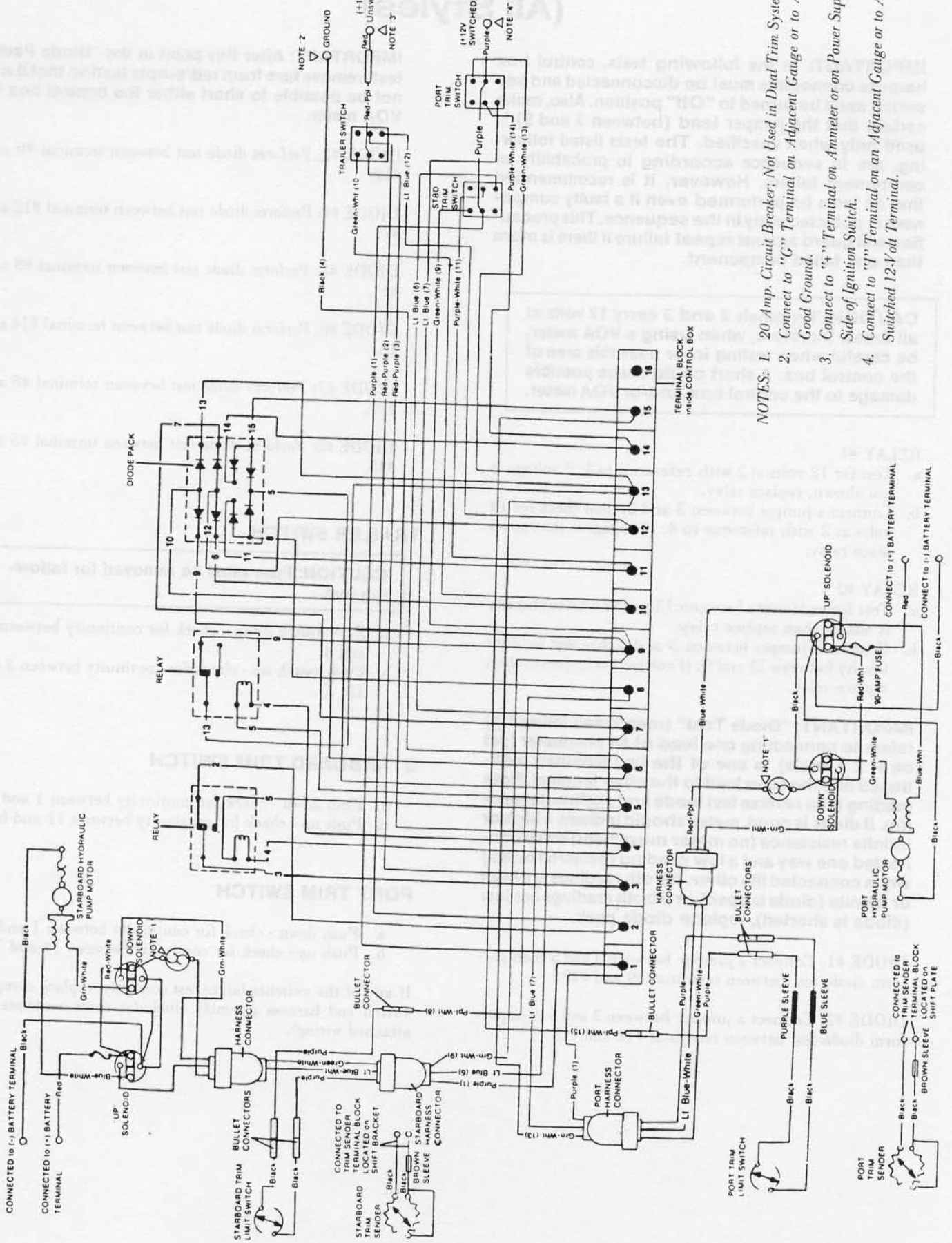
STARBOARD TRIM SWITCH

a. Push down - check for continuity between 1 and 9.
b. Push up - check for continuity between 11 and 6.

PORT TRIM SWITCH

a. Push down - check for continuity between 1 and 13.
b. Push up - check for continuity between 14 and 7.

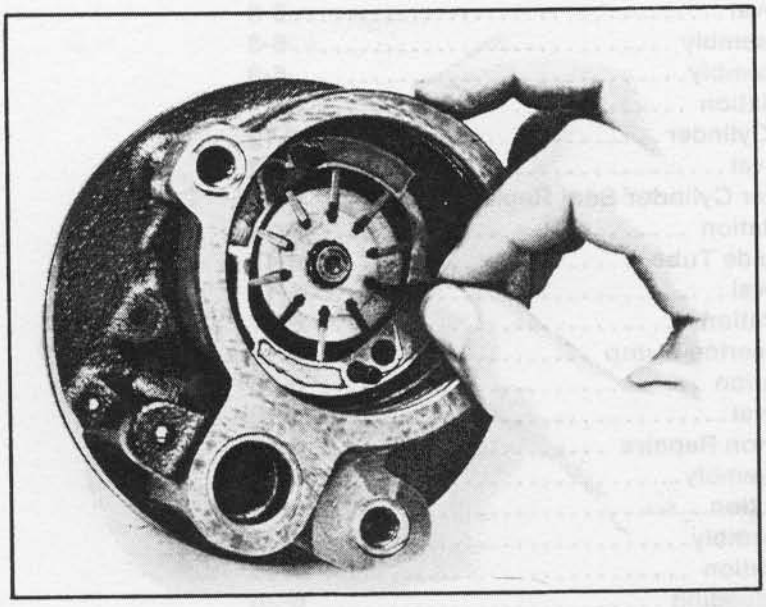
If any of the switches fail to test correctly, replace complete switch and harness assembly (includes three switches and attached wiring).



NOTES: 1. 20 Amp. Circuit Breaker; Not Used in Dual Trim System.
2. Connect to "G" Terminal on Adjacent Gauge or to Any Good Ground.
3. Connect to "+" Terminal on Ammeter or on Power Supply Side of Ignition Switch.
4. Connect to "I" Terminal on an Adjacent Gauge or to Any Switched 12-Volt Terminal.

I-DRIVE

Power Steering



SECTION 6

INDEX

	Page
Specifications	6-1
Power Steering Description	6-2
Neutral Mode	6-2
Left Turn Mode	6-2
Right Turn Mode	6-4
Power Steering Testing	6-5
Power Steering System Pressure Test	6-6
Pump Pressure Test	6-6
Booster Cylinder Test	6-7
Power Steering Components	6-8
Control Valve	6-8
Removal	6-8
Disassembly	6-8
Reassembly	6-9
Installation	6-11
Booster Cylinder	6-12
Removal	6-12
Booster Cylinder Seal Replacement	6-13
Installation	6-14
Cable Guide Tube	6-17
Removal	6-17
Installation	6-17
Power Steering Pump	6-18
Operation	6-18
Removal	6-19
Common Repairs	6-19
Disassembly	6-20
Inspection	6-23
Reassembly	6-23
Installation	6-26
Filling and Bleeding	6-26
Control Valve Balancing	6-26

SPECIFICATIONS

TORQUE SPECIFICATIONS		
Description	**Thread**	**Torque**
Metal Pressure Line Fittings	7/16-24	95 In. Lbs. (144kg-cm)
Control Valve Housing to Adaptor Housing Screws	3/8-16	20-30 Ft. Lbs. (2.8-4mkg)
Adaptor Block to Ball Stud Special Nut	1/2-20	30-40 Ft. Lbs. (4-5.5mkg)
Control Valve Clamp Screw	3/16-16	15-20 Ft. Lbs. (2.1-2.8mkg)
Pump Return Hose to Control Valve Fitting	5/8-18	20-25 Ft. Lbs. (2.8-3.5mkg)
Pump Pressure Hose to Control Valve Fitting	7/16-24	103 In. Lbs.
Steering Cable Coupler Nut	7/8-14	35 Ft. Lbs. (4.8mkg)
Booster Cylinder Pivot Bolts	1/2-20	25-35 Ft. Lbs. (3.5-4.8mkg)
Extension Shaft to Cylinder Piston Rod	3/8-24	12-15 Ft. Lbs. (1.7-2.1mkg)
Mounting Tube	7/8-14	120 In. Lbs. (138kg-cm)
Mounting Tube Jam Nut	7/8-14	35-40 Ft. Lbs. (4.8-5.5mkg)
Booster Cylinder Retainer to Swivel Mount Nuts (In-Line Power Steering)	3/8-24	15-20 Ft. Lbs. (2.1-2.8mkg)
Cable End Adaptor to Piston Rod Flexloc Nut (In-Line Power Steering)	3/8-24	15-25 Ft. Lbs. (2.1-3.5mkg)
Cable End Adaptor to Steering Lever Attaching Bolt Castle Nut (In-Line Power Steering)	1/4-28	120 In. Lbs. Max. (then Back Off to Nearest Cotter Pin Hole)
Cable Guide Tube Mounting Sleeve	7/8-14	30-40 Ft. Lbs. (4-5.5mkg)
Pump Mounting Reservoir Bolts	3/8-16	35 Ft. Lbs. (4.8mkg)
Flow Control Union Fitting	3/4-16	35 Ft. Lbs. (4.8mkg)
Pressure Hose Fitting (Pump End)	5/8-18	35 Ft. Lbs. (4.8mkg)

SPECIAL TOOLS	
Tool Description	**Part No.**
Power Steering Test Gauge	C-91-38053A3
(1-3/8 - 12 Point Crow's-Foot)	C-91-89035
(Power Steering Pump) Pulley Remover (from Kent-Moore)	J-25034 or J-21239-1 (Kent-Moore)
(Power Steering Pump) Pulley Installer	C-91-71803A1
Pulley Spacer	B-23-91834

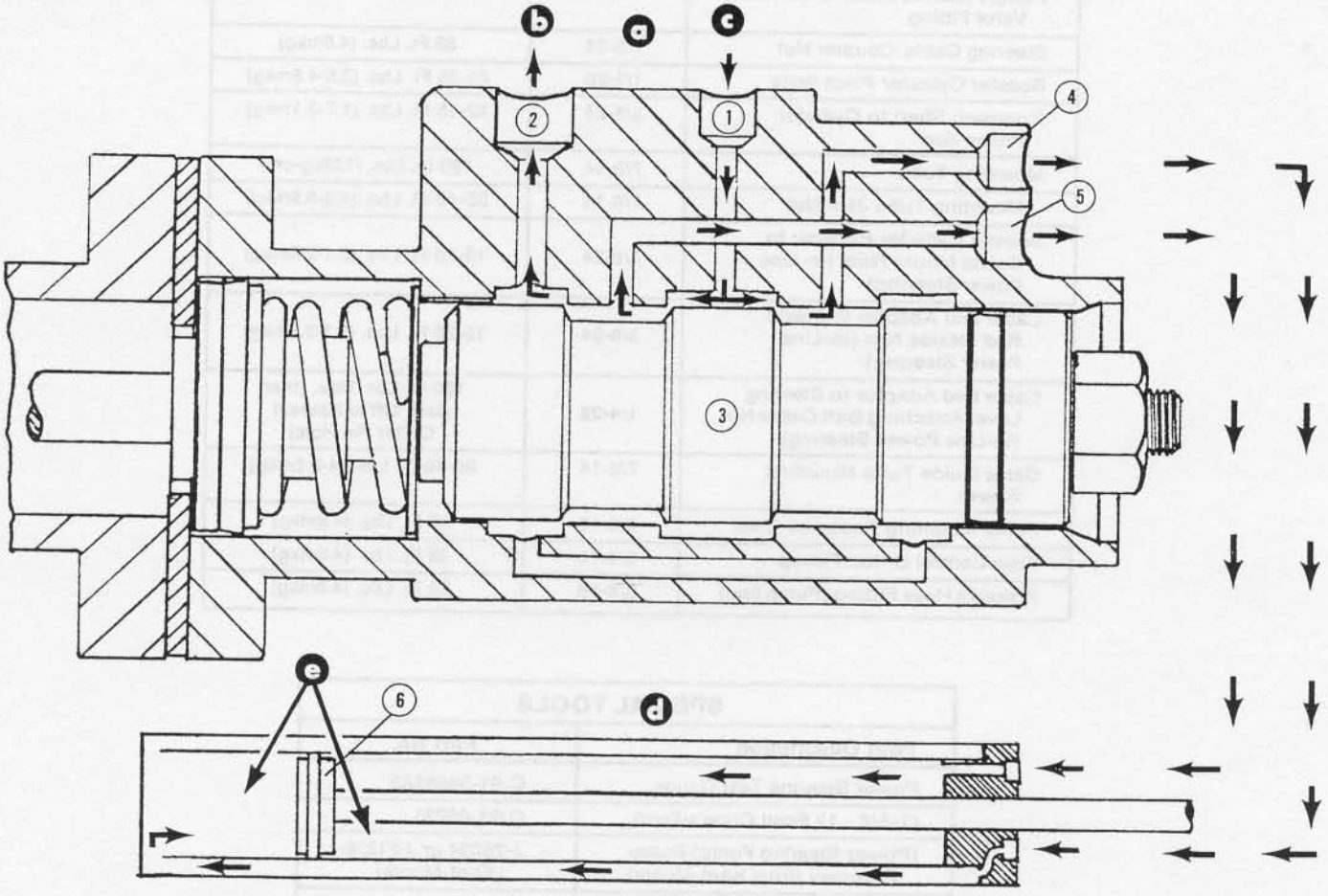
POWER STEERING DESCRIPTION

The MerCruiser Power Steering System utilizes an engine-driven, vane-type hydraulic pump that supplies fluid flow and pressure by means of hoses to a control valve that, in turn, controls fluid flow and pressure to-and-from a booster cylinder. Three modes make up the basic function of the Power Steering System: 1) Neutral mode, 2) right-turn mode and 3) left-turn mode. The control valve, which is activated by the steering cable, controls the steering system modes.

NOTE: The following V-8 Power Steering unit illustrations are viewed from inside boat, looking at transom.

NEUTRAL MODE (Figure 1)

When the engine is running, fluid pressure is constantly circulating from the pump thru the control valve and back to the pump. With the control valve in neutral position, (steering wheel not moving), fluid enters the pressure port ① and is directed by the lands on the spool ③ to the return port ② and booster cylinder ports ④ and ⑤. Since the same pressure is routed thru both ④ and ⑤, the piston rod remains steady. The fluid that flows to the return port ② leaves the control valve and, after passing thru a Power Steering oil cooler, returns to the pump.



a - Control Valve
b - Return to Pump
c - Pressure from Pump
d - Booster Cylinder
e - Equal Pressures (Causes Piston to Remain Steady)

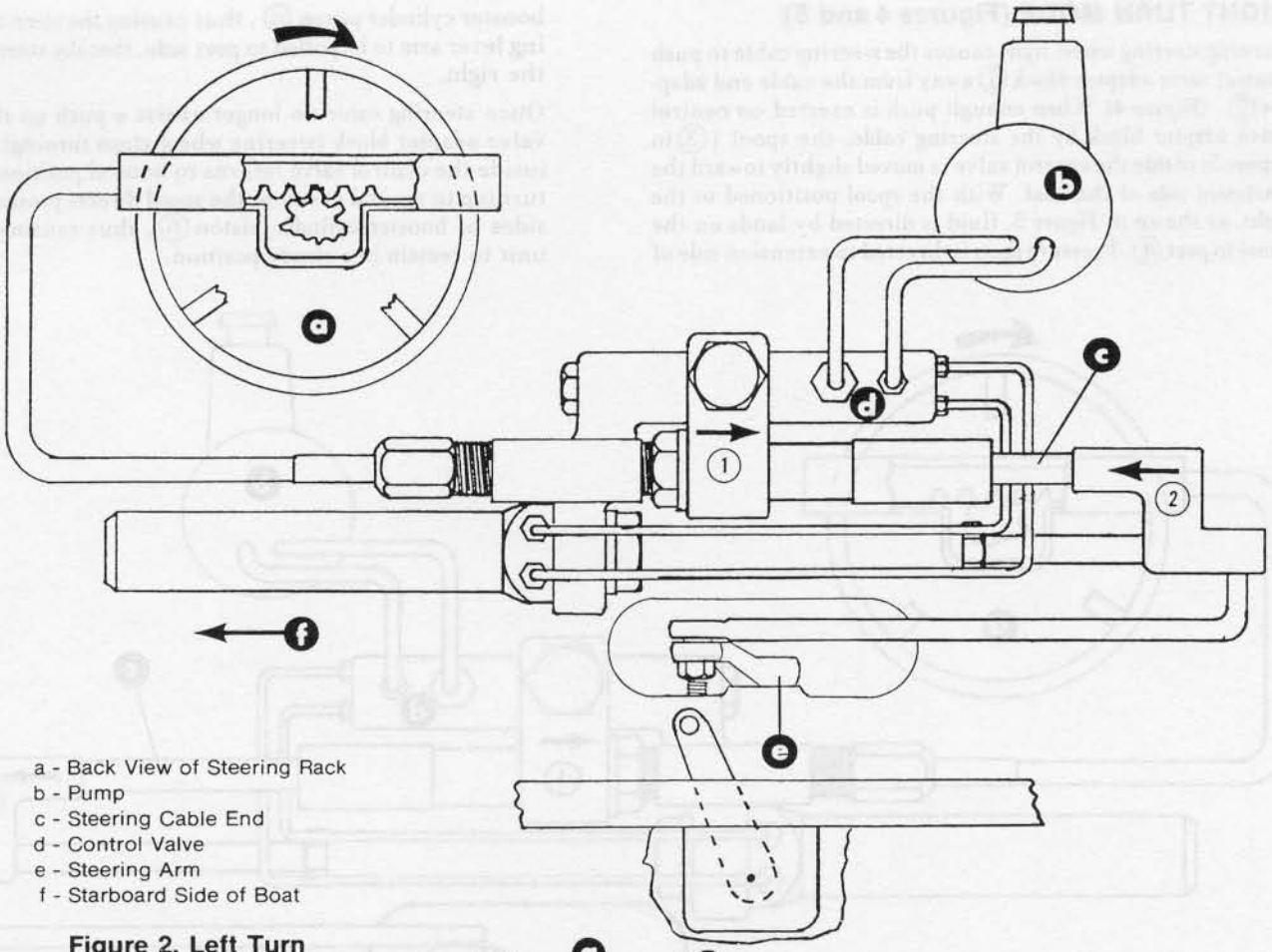
Figure 1. Neutral Mode

LEFT TURN MODE (Figures 2 and 3)

Turning steering wheel left causes the steering cable to pull control valve adaptor block ① toward the cable end adaptor ②. (Figure 2) When enough pull is exerted on control valve adaptor block by the steering cable, the spool (③ in Figure 3) inside the control valve is moved slightly to the port side of boat.

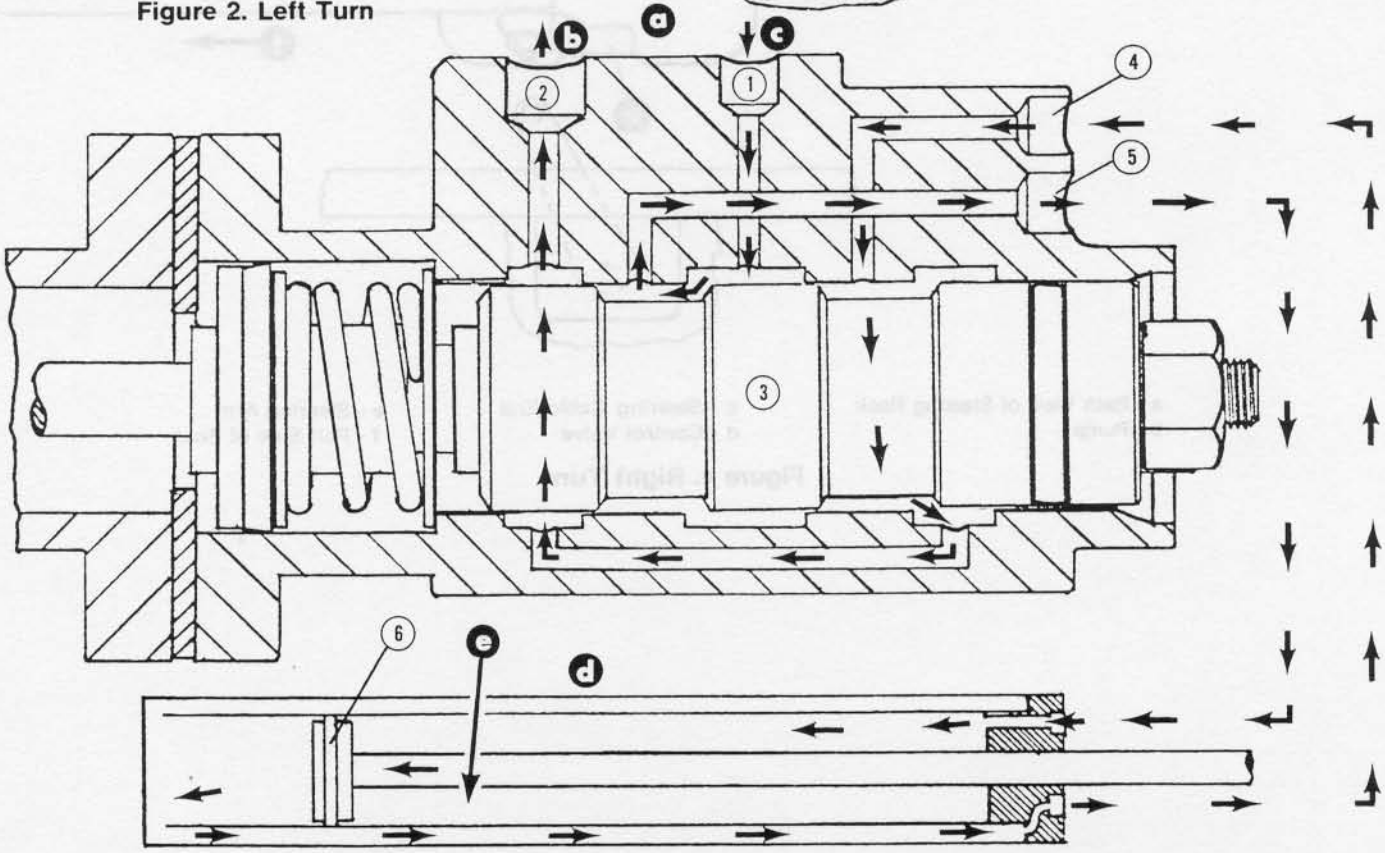
With the spool position to the left, as shown in Figure 3, fluid is directed by the lands on the spool to retraction port ⑤. Pressure then is directed to retraction side of booster cylinder piston ⑥, thus causing the stern drive steering lever arm to be pushed to starboard side, thereby steering boat to the left.

Once the steering cable no longer exerts a pull on the control valve adaptor block (steering wheel stops turning), the spool inside the control valve returns to neutral position. Upon returning to neutral position, the spool directs pressure to both sides of booster cylinder piston ⑥, thus causing the drive unit to remain in a steady position.



a - Back View of Steering Rack
b - Pump
c - Steering Cable End
d - Control Valve
e - Steering Arm
f - Starboard Side of Boat

Figure 2. Left Turn



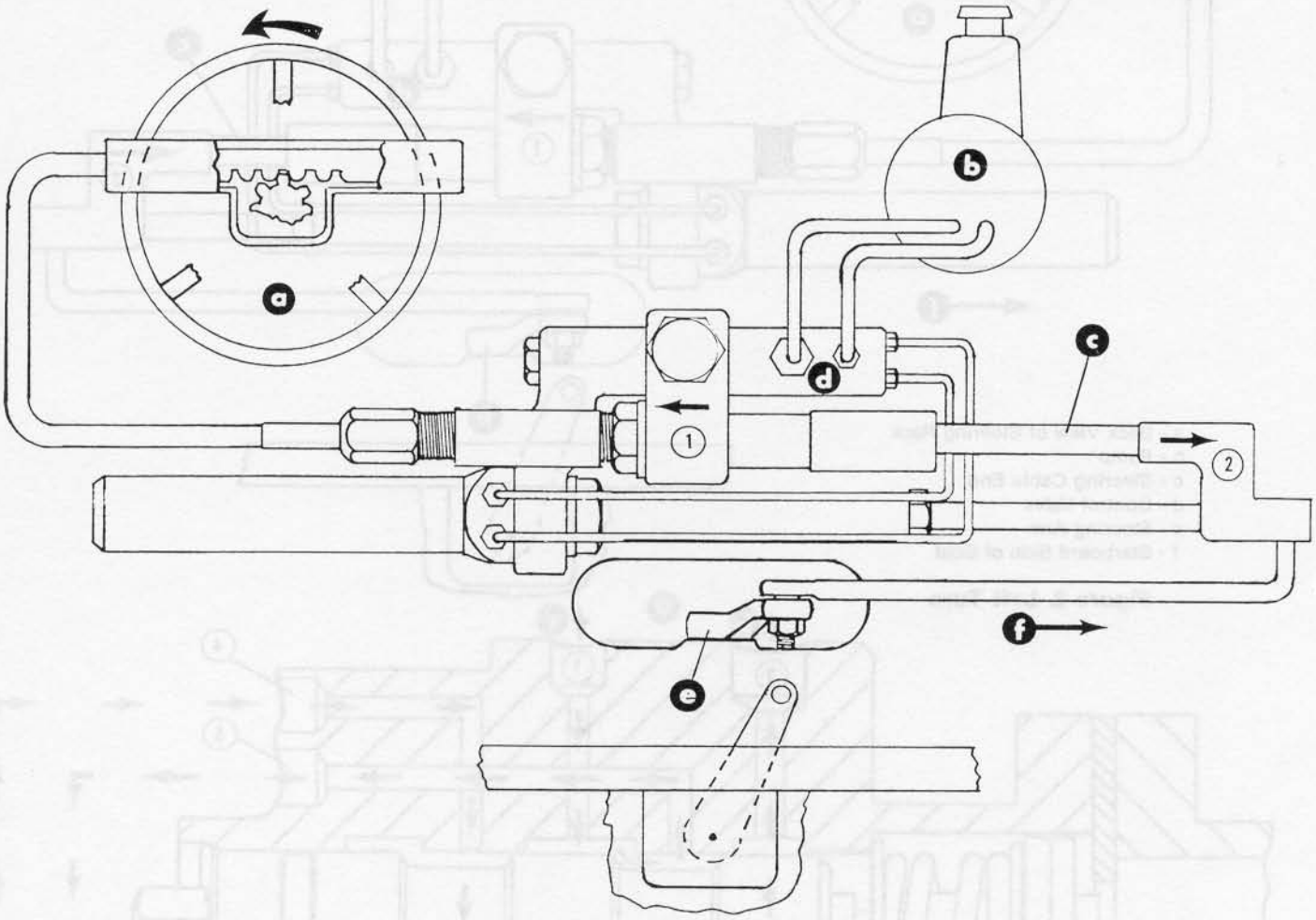
a - Control Valve
b - Return to Pump
c - Pressure from Pump
d - Booster Cylinder
e - Pressure Greater on This Side of Piston (Piston Rod Retracts)

Figure 3. Left Turn Mode

RIGHT TURN MODE (Figures 4 and 5)

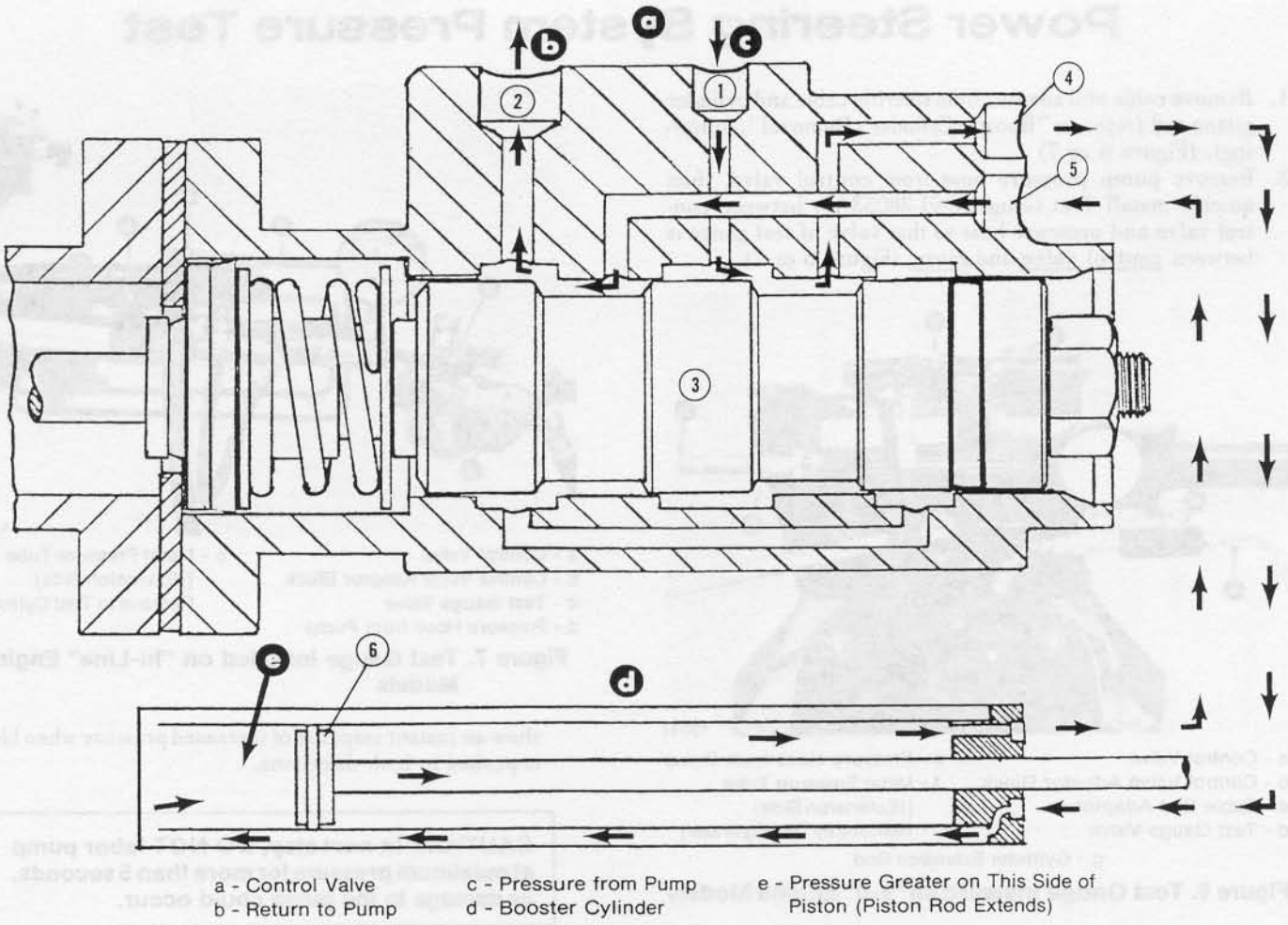
Turning steering wheel right causes the steering cable to push control valve adaptor block ① away from the cable end adaptor ②. (Figure 4) When enough push is exerted on control valve adaptor block by the steering cable, the spool (③ in Figure 5) inside the control valve is moved slightly toward the starboard side of the boat. With the spool positioned to the right, as shown in Figure 5, fluid is directed by lands on the spool to port ④. Pressure then is directed to extension side of booster cylinder piston ⑥, thus causing the stern drive steering lever arm to be pulled to port side, thereby steering boat to the right.

Once steering cable no longer exerts a push on the control valve adaptor block (steering wheel stops turning), the spool inside the control valve returns to neutral position. Upon returning to neutral position, the spool directs pressure to both sides of booster cylinder piston ⑥, thus causing the drive unit to remain in a steady position.



a - Back View of Steering Rack
b - Pump
c - Steering Cable End
d - Control Valve
e - Steering Arm
f - Port Side of Boat

Figure 4. Right Turn



a - Control Valve
b - Return to Pump
c - Pressure from Pump
d - Booster Cylinder
e - Pressure Greater on This Side of Piston (Piston Rod Extends)

Figure 5. Right Turn Mode

POWER STEERING TESTING

IMPORTANT: Before proceeding with "Power Steering Testing", install test gauge between Power Steering pressure hose and control valve. (See Figure 6 or 7.) Turn steering wheel to hard left and observe pressure on gauge. If gauge indicates a pressure over 125 psi (8.8kg/cm²), check the following.

a. Check that steering lever is not contacting cutout in transom. If contact is being made, modify cutout.
b. If (a.), above, is not the cause, then install spacer (C-12-62402) over steering cable so that spacer is between cable guide tube and cable end adaptor.

Turn steering wheel to hard right and observe pressure on gauge. If gauge indicates a pressure over 125 psi (8.8kg/cm²), check the following:

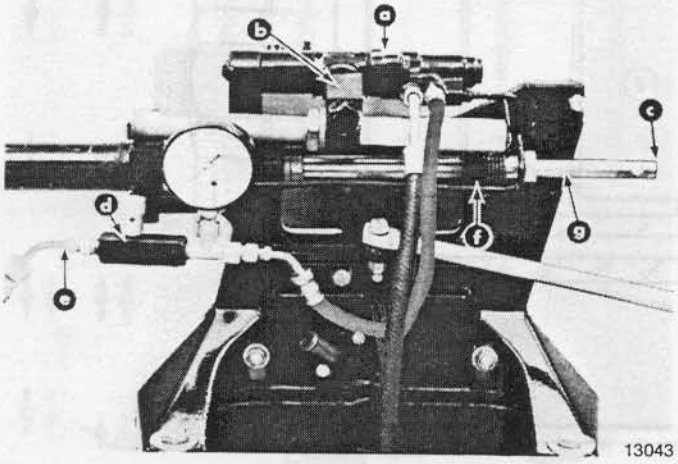
a. Check that steering lever is not contacting cutout in transom. If contact is being made, modify cutout.
b. Check that steering link rod (V-8 models only) is installed in the innermost hole of the cable end adaptor. (Figure 6)
c. If (a. or b.), above, is not the cause, then end dimension of steering cable is incorrect. Replace old steering cable with new steering cable that has end dimension as described in B.I.A. handbook (refer to "General Information", Section 1 of this manual).

CAUTION: If the steering system is installed so that the Power Steering pump is reaching maximum pressure in a hard turn, damage to the pump could occur if the steering wheel is held in the hard turn.

The following instructions are arranged so that, by the process of elimination, a defective part (if any) can be detected. It is suggested that the order of the instructions be followed so that the Power Steering System can be tested effectively.

Power Steering System Pressure Test

1. Remove cable end adaptor from steering cable and cylinder piston rod (refer to "Booster Cylinder - Removal", following). (Figure 6 or 7)
2. Remove pump pressure hose from control valve, then quickly install Test Gauge (C-91-38053A3) between control valve and pressure hose so that valve of test gauge is between control valve and gauge. (Figure 6 or 7)

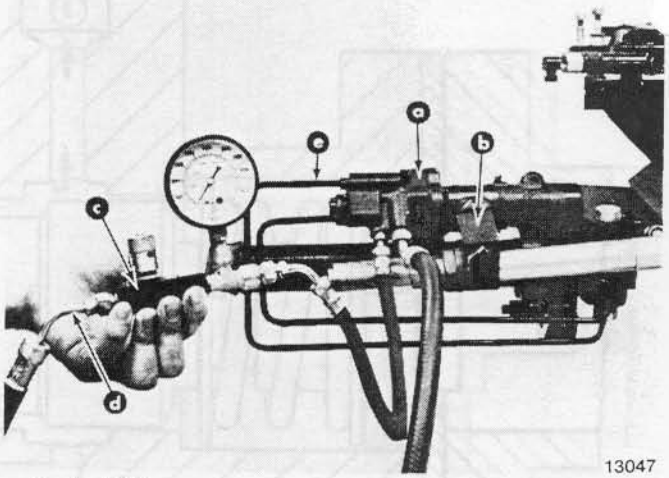


a - Control Valve
b - Control Valve Adaptor Block
c - Cable End Adaptor
d - Test Gauge Valve
e - Pressure Hose from Pump
f - Metal Pressure Tube [(Extension Side) Remove to Test Cylinder]
g - Cylinder Extension Rod

Figure 6. Test Gauge Installed on "V-8" Engine Models

CAUTION: DO NOT operate engine without cooling water flowing thru water pump, or water pump impeller will be damaged, and subsequent engine damage may result.

3. Be sure that test gauge valve is open, then start engine and allow system to reach operating temperature. Also check fluid level and add fluid if necessary. Pressure gauge should read a minimum of 70 to 125 psi (4.9 to 8.8kg/cm²) while engine is idling.
4. Push control valve adaptor block (Figure 6 or 7) in the starboard, then port, directions. Gauge reading should show an instant response of increased pressure when block is pushed in both directions.



a - Control Valve
b - Control Valve Adaptor Block
c - Test Gauge Valve
d - Pressure Hose from Pump
e - Metal Pressure Tube [(Extension Side) Remove to Test Cylinder]

Figure 7. Test Gauge Installed on "In-Line" Engine Models

CAUTION: In next step, DO NOT labor pump at maximum pressure for more than 5 seconds, or damage to the pump could occur.

5. Push control valve adaptor block in the port direction until booster cylinder piston rod is fully retracted. With piston rod in this position, momentarily push control valve adaptor block in the port direction just until a maximum pressure reading is obtained.
6. If maximum pressure reading is:
   a. At or above 1,000 psi (70kg/cm²), the Power Steering System pressure is OK.
   b. Below 1,000 psi and/or idle pressure is low, then proceed with the following tests.
7. If idle pressure is higher than 125 psi (8.8kg/cm²), check for hose restrictions in the system.

Pump Pressure Test

CAUTION: In the next step, DO NOT labor pump at maximum pressure for more than 5 seconds, or damage to the pump and possible fire could occur.

1. With test gauge still installed as described (preceding) and engine idling, shut test gauge valve just long enough to obtain a maximum pressure reading. Close-and-open test valve 3 times and record the highest pressure attained each time.
2. If the pressures recorded are:
   a. Between 1150-1250 psi (81-88kg/cm²), and the range of readings is within 50 psi (3.5kg/cm²), the pump is within specifications. An example of readings from a good pump - 1170-1175-1180 psi (82.3-82.6-82-9kg/

cm²). If the pump tests OK, but Power Steering System Pressure (preceding) is low, proceed with "Booster Cylinder Test", following.

b. Between 1150-1250 but does not repeat within 50 psi, the pump flow control valve is sticking. Remove the valve, clean it and remove any burrs (use crocus cloth or fine hone). If the system contains some dirt, flush it. If it is extremely dirty, the pump must be completely disassembled, cleaned and reassembled before further use. While disassembled, inspect component parts for wear and replace as required.

c. Constant, but below 1000 psi (70kg/cm²), then replace the flow control valve and recheck. If the pressures are still low, refer to possible causes and corrections in chart, following.

POSSIBLE CAUSE	CORRECTION
1. Flow control valve stuck or inoperative	1. Remove burrs or nicks or replace.
2. Pressure plate not flat against cam ring	2. Correct.
3. Extreme wear of cam ring	3. Replace parts; flush system.
4. Scored pressure plate, thrust plate or rotor	4. Replace parts (if rotor, replace with rotating group kit); flush system.
5. Vanes not installed properly	5. Install properly.
6. Vanes sticking in rotor slots	6. Free-up by removing burrs or nicks.
7. Cracked or broken thrust or pressure plate	7. Replace part.

NOTE: For pump repairs, refer to "Power Steering Pump" section, following.

Booster Cylinder Test

1. With the cylinder piston rod in the fully retracted position and engine not running, remove metal tube that joins the extension port of control valve to extension port of cylinder. (Figure 6 or 7)
2. Plug both extension ports (with plugs supplied in test gauge kit) and tighten securely.

CAUTION: DO NOT labor pump at maximum pressure for more than 5 seconds, or damage to the pump and possible fire could occur.

3. Check fluid level in pump (add if necessary), then start engine and let idle. Push control valve adaptor block in the port direction momentarily. Repeat this procedure a few times, while noticing if piston rod starts extending from cylinder.
4. If piston rod . . .
   a. extends, replace booster cylinder (refer to "Booster Cylinder" section) and test Power Steering System again. If pump is OK, and booster cylinder is OK but Power Steering System pressure is low, then replace control valve. (Refer to "Control Valve" section.)
   b. does not extend, but Power Steering System Pressure is low, replace control valve.
5. Remove plugs from extension ports in control valve and booster cylinder. Install metal pressure line removed previously. Be sure to tighten to specifications.
6. Disconnect test gauge and reconnect pump pressure hose to control valve. (Figure 6 or 7)
7. Install cable end adaptor to steering cable end and cylinder piston rod (refer to "Booster Cylinder - Installation").
8. Fill and bleed Power Steering System according to instructions under "Filling and Bleeding", following.

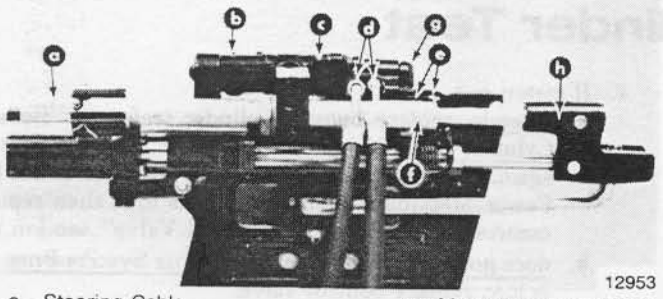
POWER STEERING COMPONENTS

Control Valve

REMOVAL

NOTE: If accessibility to control valve area is limited, it will be easier to remove Power Steering unit from transom, then remove control valve from Power Steering unit (refer to "Booster Cylinder - Removal", following).

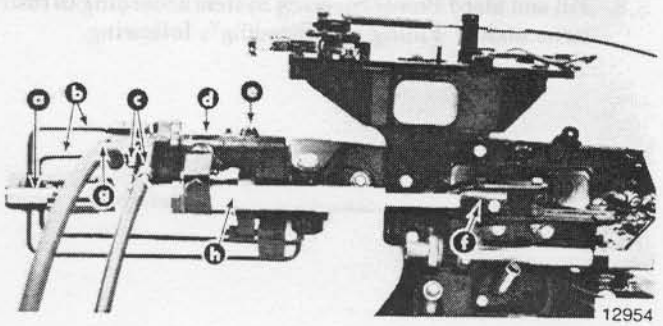
1. Turn steering wheel hard left. Remove clevis pin, that secures steering cable to cable end adaptor, and remove steering cable from cable guide tube. (Figure 8 or 9)



12953

a - Steering Cable
b - Clamp Screw
c - Control Valve
d - Power Steering Pump Hydraulic Hoses
e - Metal Pressure Tubes
f - Cable Guide Tube
g - Dust Cover
h - Cable End Adaptor

Figure 8. Removing Control Valve ("V-8" Engine Models)

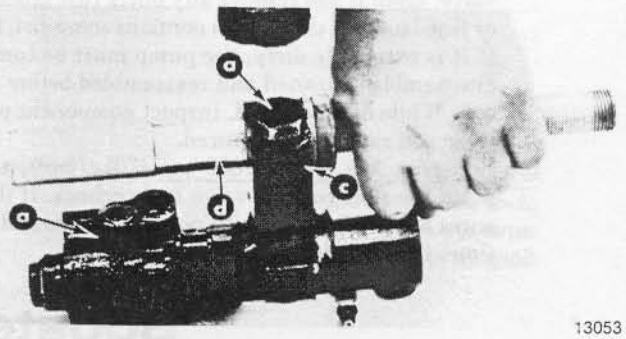


12954

a - Steering Cable
b - Metal Pressure Tubes
c - Power Steering Pump Hydraulic Hoses
d - Control Valve
e - Clamp Screw (Hidden)
f - Cable End Adaptor
g - Dust Cover
h - Cable Guide Tube

Figure 9. Removing Control Valve ("In-Line" Engine Models)

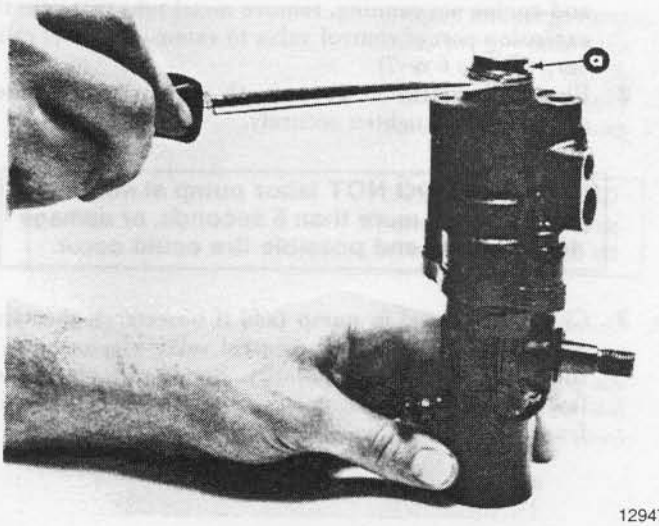
2. Disconnect Power Steering pump hydraulic hoses from control valve. (Figure 8 or 9) Cap hoses to prevent leakage.
3. Disconnect metal pressure tubes from control valve. Fittings may be more accessible if control valve dust cover is removed first. (Figure 8 or 9)
4. Remove clamp screw (Figure 8 or 9) and slide control valve from Power Steering unit.



13053

a - Control Valve b - Ball Stud c - Adaptor Block d - Guide Tube

Figure 10. Removing Cable Guide Tube



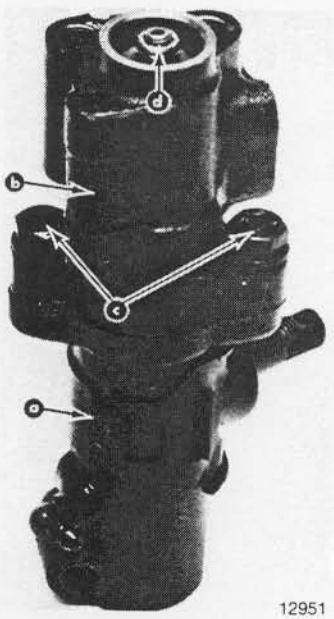
12947

a - Dust Cover

Figure 11. Removing Dust Cover

DISASSEMBLY

1. Remove cable guide tube from control valve ball stud by loosening adaptor block to ball stud nut and tapping on end of nut. After adaptor block is loose from ball stud, remove nut and adaptor block and guide tube assembly. (Figure 10)

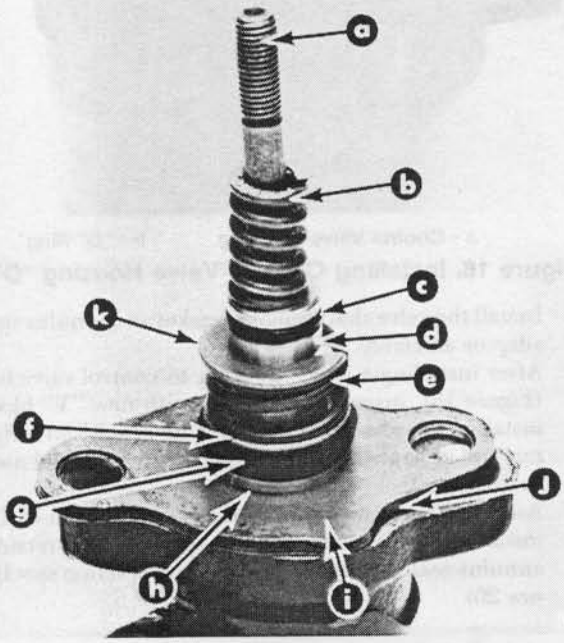


12951

a - Adaptor
b - Valve Housing
c - Valve to Adaptor Screws (2)
d - Adjusting Nut

Figure 12. Separating Valve Housing from Adaptor

2. Remove dust cover from end of control valve. (Figure 11)
3. Remove adjusting nut and valve to adaptor bolts, then remove valve housing from adaptor. (Figure 12) (Spool will remain in valve housing.)
4. Remove spool from valve housing and remove spring, reaction spool, washer, reaction spring, spring retainer, seal and large ID washer from valve shaft. Also remove "O" ring from reaction spool and "V" block seal from valve spool. (Figure 13)
5. Remove annulus spacer and gasket from adaptor housing. (Figure 13)

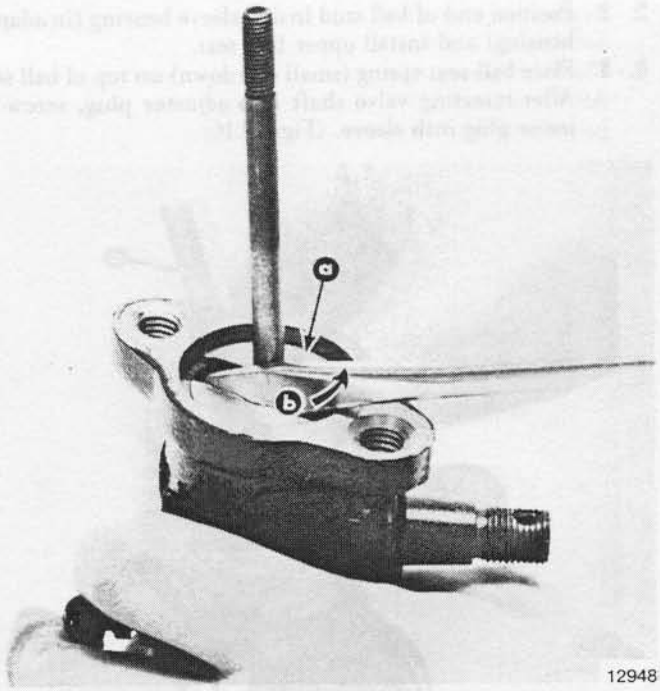


12950

a - Valve Shaft
b - Adjusting Spring
c - "O" Ring
d - Reaction Spool
e - Valve Spring
f - Spring Retainer
g - Annulus Seal
h - Large ID Washer
i - Annulus Spacer
j - Gasket
k - Spring Thrust Washer

Figure 13. Valve Parts Location

6. Remove small washer and plug to sleeve key. Now carefully (so it won't nick the top surface) turn adjuster plug out of sleeve. (Figure 14)



12948

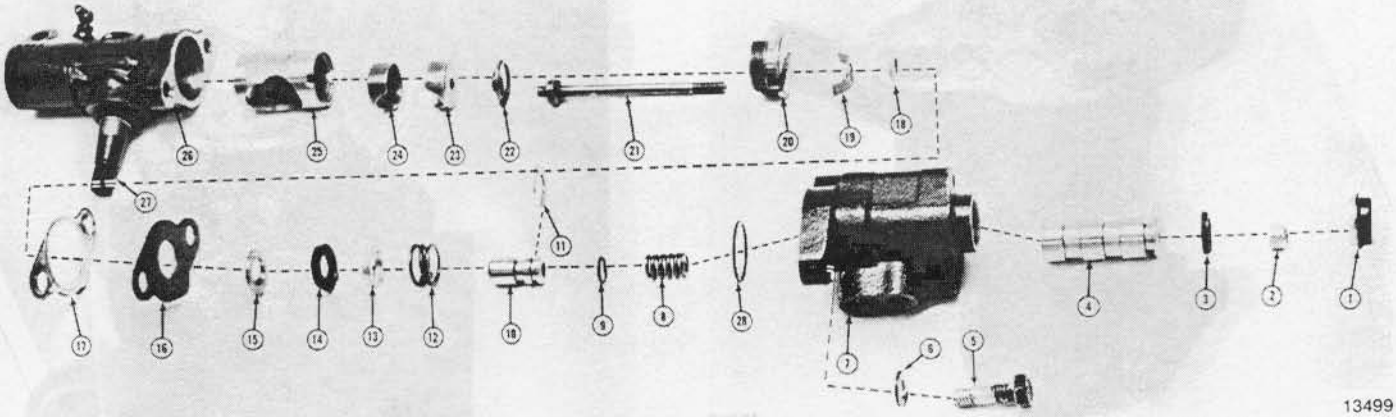
a - Adjuster Plug
b - Turn in Counterclockwise Direction

Figure 14. Turning Adjuster Plug out of Sleeve

7. Remove valve shaft, ball seat spring and upper ball seat. Release ball stud from sleeve bearing and pull it into the rubber boot.
8. Pull ball stud into rubber boot just enough to gain clearance, then remove bearing sleeve and lower ball seat.
9. Wash all metal parts in a non-toxic solvent, remove all grease and blow dry with compressed air. If any metal part shows signs of adverse wear, replace control valve assembly.

REASSEMBLY

1. Insert lower ball seat into sleeve bearing. Now, while pulling ball stud into rubber boot, install sleeve bearing into adaptor housing while aligning hole in sleeve with ball stud. (Figure 15)

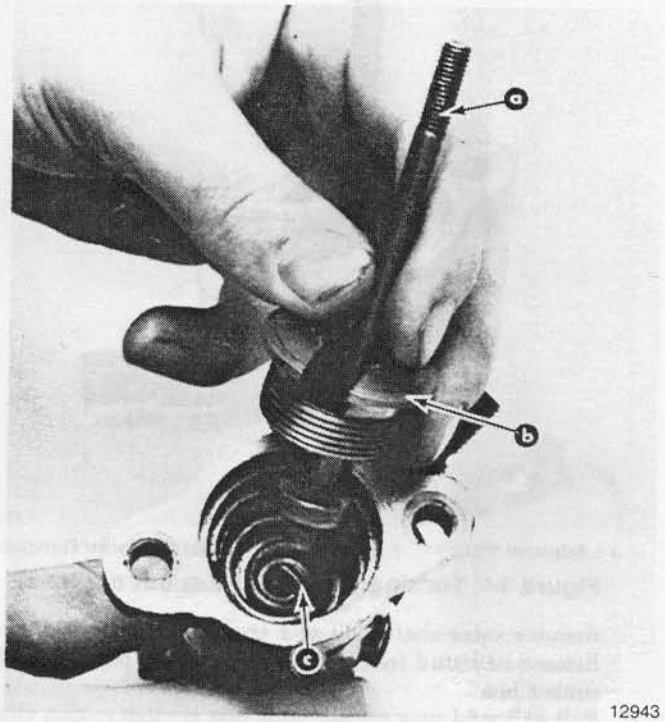


13499

1 - Dust Cover
2 - Adjusting Nut
3 - "V" Block Seal
4 - Valve Spool
5 - Valve Mounting Bolt (2)
6 - Lockwashers (2)
7 - Valve Housing
8 - Valve Adjustment Spring
9 - "O" Ring Seal
10 - Valve Reaction Spool
11 - Spring Thrust Washer
12 - Valve Spring
13 - Spring Retainer
14 - Annulus Seal
15 - Large ID Washer
16 - Annulus Spacer
17 - Gasket
18 - Valve Shaft Washer
19 - Plug to Sleeve Key
20 - Ball Adjuster Nut
21 - Valve Shaft
22 - Ball Seat Spring
23 - Upper Ball Seat
24 - Lower Ball Seat
25 - Sleeve Bearing
26 - Adaptor Housing
27 - Ball Stud
28 - "O" Ring

Figure 15. Power Steering Control Valve and Adaptor Assembly

2. Position end of ball stud inside sleeve bearing (in adaptor housing) and install upper ball seat.
3. Place ball seat spring (small coil down) on top of ball seat. After inserting valve shaft into adjuster plug, screw adjuster plug into sleeve. (Figure 16)



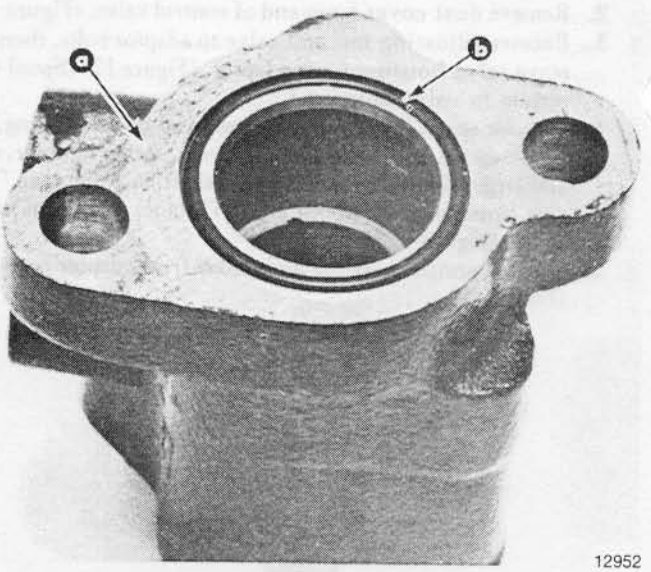
a - Valve Shaft
b - Adjuster Plug
c - Ball Seat Spring (Small Coil Down)

Figure 16. Replacing Adjuster Plug and Shaft

a - Key
b - Tang

Figure 17. Proper Key Installation

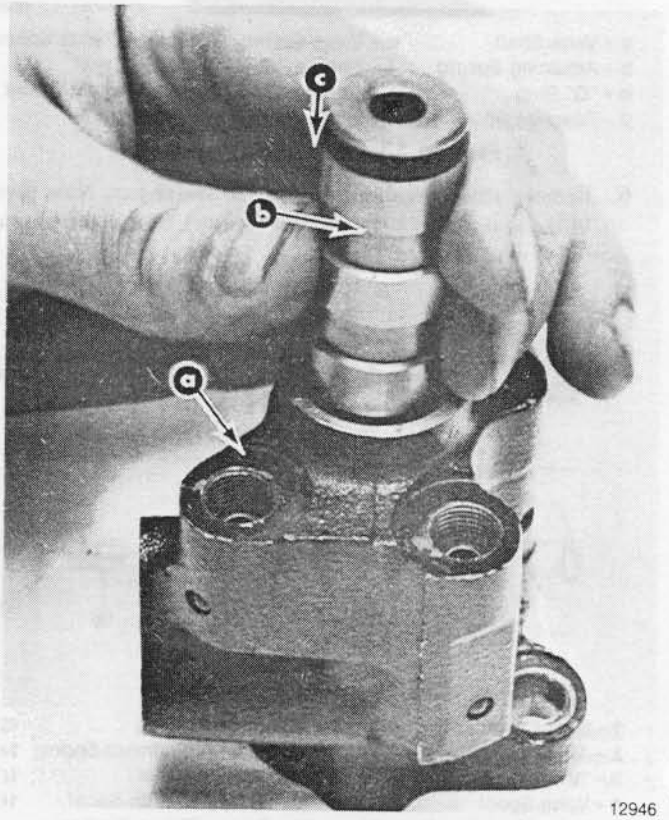
4. Turn plug in until it is tight, then back it off until slot lines up with notches in sleeve.
5. Insert key, making sure that small tangs on ends of key fit into notches in sleeve. (Figure 17)



a - Control Valve Housing
b - "O" Ring

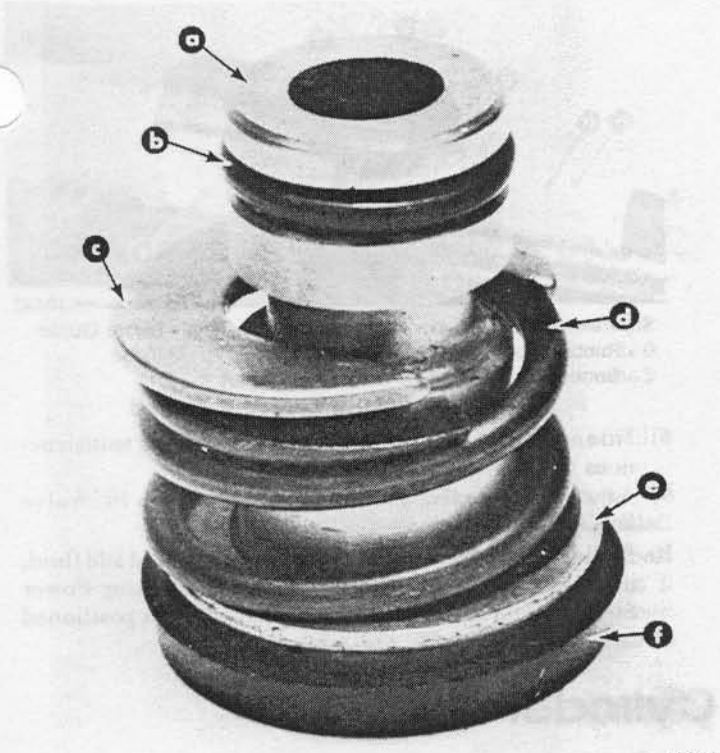
Figure 18. Installing Control Valve Housing "O" Ring

6. Install the valve shaft washer, gasket and annulus spacer to adaptor assembly. (Figure 15)
7. After installing a new "O" ring to control valve housing (Figure 18), insert valve spool [with new "V" block seal installed (lip of seal facing lands on spool)] into adjusting nut end of control valve. (Figure 19) Be careful not to invert the seal.
8. Assemble (as a unit) the reaction spool (with new "O" ring installed), thrust washer, valve spring, spring retainer and annulus seal (lip facing "O" ring on reaction spool). (Figure 20)



a - Control Valve Housing
b - Spool
c - Lip of Seal Facing This Direction

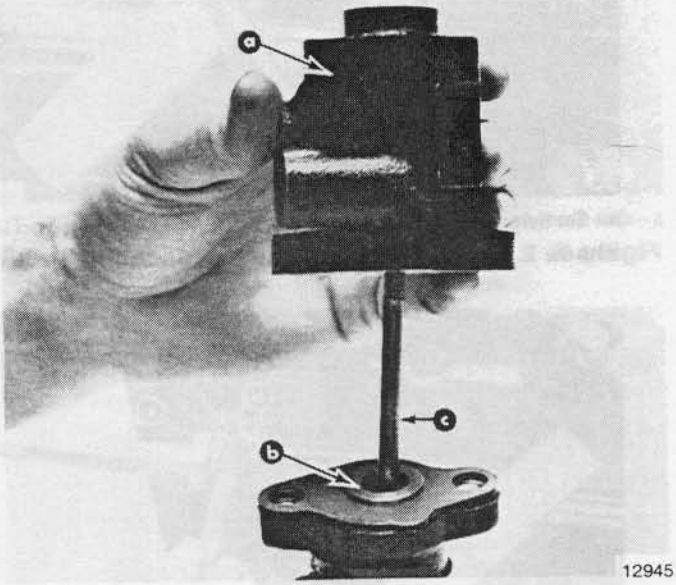
Figure 19. Installing Valve Spool into Control Valve



12944

a - Reaction Spool
b - "O" Ring
c - Thrust Washer
d - Valve Spring
e - Spring Retainer
f - Annulus Seal

Figure 20. Assembling Reaction Spool Components

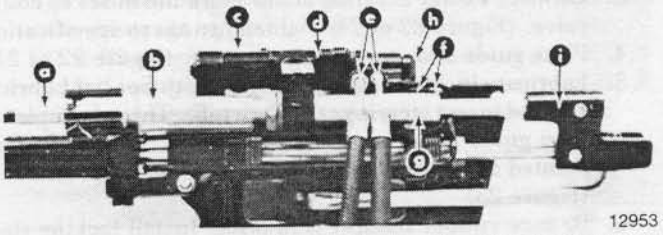


12945

a - Control Valve Assembly
b - Large ID Washer in Position
c - Valve Shaft

Figure 21. Installing Control Valve Assembly

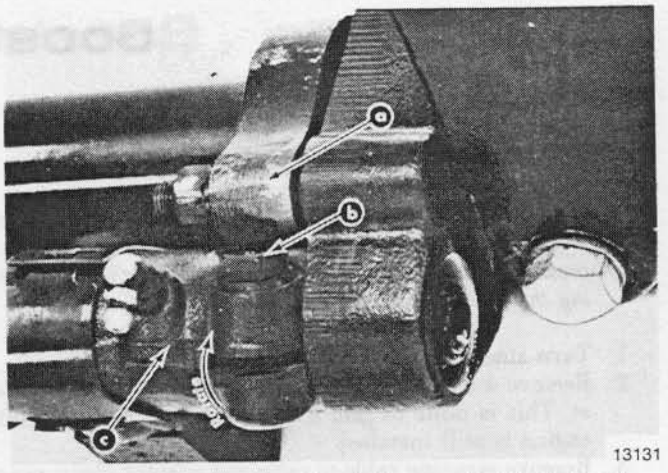
9. Insert adjusting spring into valve spool cavity (inside control valve) and components assembled in Step 8 into larger cavity of control valve ("O" ring end of reaction spool first). Be careful not to invert annulus seal when installing.
10. Position large ID washer over valve shaft and install control valve assembly over valve shaft. (Figure 21)
11. Position annulus spacer so that it matches control valve housing, then secure adaptor housing to control valve housing with 2 screws (Figure 15) and tighten to specifications.
12. Depress valve spool and turn locknut onto valve shaft about 4 turns with a clean wrench or socket.
13. Install dust cover (Figure 15) and lubricate control valve thru grease fitting with Universal Joint Lubricant (from U-Join Grease Kit) until grease appears around rubber boot.
14. Place guide tube and adaptor block over ball stud and secure with special nut and internal lockwasher. Torque nut to specification.



12953

a - Steering Cable
b - Guide Slide
c - Clamp Screw
d - Control Valve
e - Power Steering Pump Hydraulic Hoses
f - Metal Pressure Tubes
g - Cable Guide Tube
h - Dust Cover
i - Cable End Adaptor

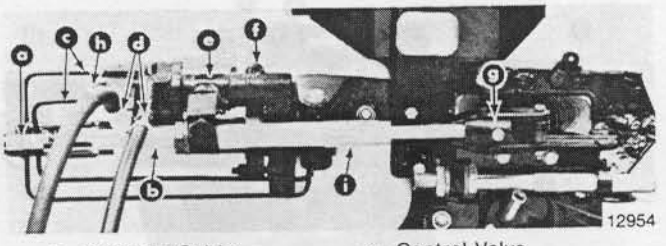
Figure 22. Installing Control Valve ("V-8" Engine Models)



13131

a - Booster Cylinder Clamping Collar
b - Clamp Screw
c - Control Valve

Figure 23. Aligning In-Line Control Valve



12954

a - Steering Cable
b - Guide Slide
c - Metal Pressure Tubes
d - Power Steering Pump Hydraulic Hoses
e - Control Valve
f - Clamp Screw (Hidden)
g - Cable End Adaptor
h - Dust Cover
i - Cable Guide Tube

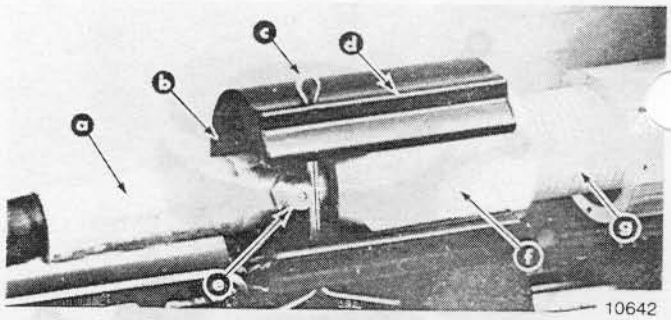
Figure 24. Installing Control Valve ("In-Line" Engine Models)

INSTALLATION

1. Slide control valve over mount on Power Steering unit. On "V-8" models, align slot in adaptor housing with boss on Power Steering mounting bracket, install clamp screw and tighten to specification. (Figure 22) On "In-Line models",

install clamp screw into adaptor housing and position control valve so that the clamp screw head touches booster cylinder clamping collar. (Figure 23) Torque clamp screw to specification.

2. Connect metal pressure lines from booster cylinder to control valve and tighten fittings to specifications. Install dust cover, if it was removed to gain access to fittings. (Figure 22 or 24)
3. Connect Power Steering pump hydraulic hoses to control valve. (Figure 22 or 24) Tighten fittings to specifications.
4. Place guide slide on cable guide tube. (Figure 22 or 24)
5. Lubricate inside of cable guide tube with Special Lubricant 101 and insert steering cable thru tube. Thread coupler nut onto guide tube, position cable so that grease fitting is pointed outward and tighten coupler nut to specification. (Figure 25)
6. Be sure rubber bumper is in place. Install locking sleeve over steering cable coupler nut and secure with cotter pin, as shown in Figure 25. Be sure to install cotter pin between grease fitting.
7. Install steering cable end into cable end adaptor and secure with clevis pin. Secure clevis pin with cotter pin (be sure to spread ends of cotter pin). (Figure 22 or 24)



10642

a - Steering Cable
b - Rubber Bumper
c - Cotter Pin
d - Locking Sleeve
e - Grease Fitting
f - Cable Coupler Nut
g - Cable Guide Tube

Figure 25. Locking Sleeve Installed

8. Fill and bleed Power Steering System according to instructions in "Filling and Bleeding", following.
9. Adjust control valve according to instructions in "Valve Balancing", following.
10. Recheck Power Steering fluid level in pump and add fluid, if necessary. DO NOT over-fill. When checking Power Steering fluid level, be sure that drive unit is positioned straight back.

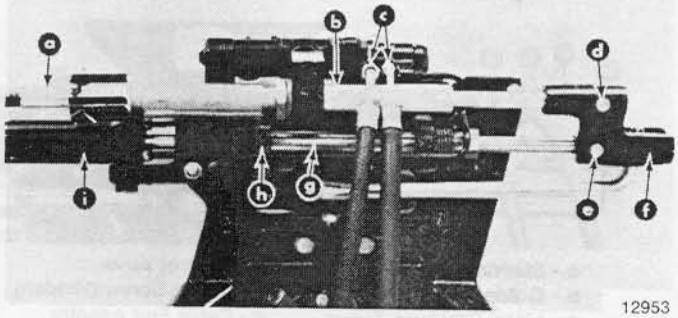
Booster Cylinder

REMOVAL

"V-8" Model Booster Cylinder Removal

NOTE: In some installations, the booster cylinder can be removed by simply removing extension rod clevis pin, 2 metal pressure lines and 2 booster cylinder mounting bolts, then sliding the cylinder away from the transom.

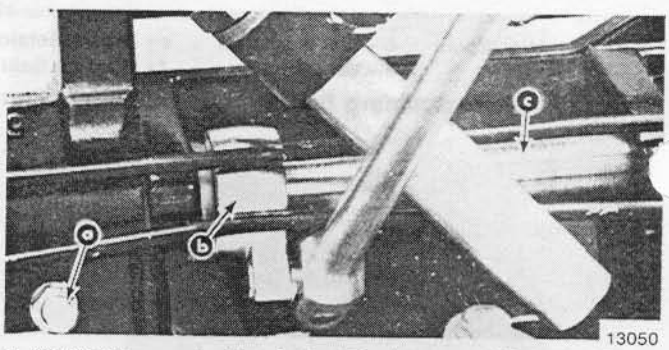
1. Turn steering wheel full left.
2. Remove 4 bolts which secure shift plate to mounting bracket. This is done to gain access to Power Steering unit, if engine is still installed.
3. Remove steering cable to cable end adaptor clevis pin and remove steering cable from cable guide tube. (Figure 1)



12953

a - Steering Cable
b - Cable Guide Tube
c - Power Steering Pump Hydraulic Hoses
d - Clevis Pin (Steering Cable to End Adaptor)
e - Clevis Pin (Extension Rod to End Adaptor)
f - Cable End Adaptor
g - Power Steering Mounting Tube
h - Power Steering Tube Jam Nut and Washer
i - Booster Cylinder

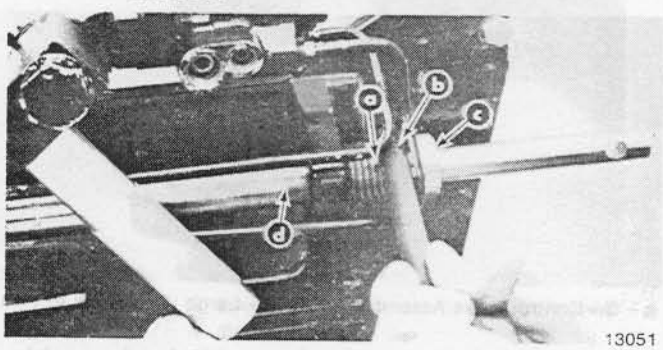
Figure 1. Removing Booster Cylinder



13050

a - Set Screw
b - Crow's-Foot Tool
c - Mounting Tube

Figure 2. Loosening Power Steering Mounting Tube Jam Nut



13051

a - Locking Spring
b - 1/8" ID Tube
c - Nut on End of Guide Tube
d - Mounting Tube

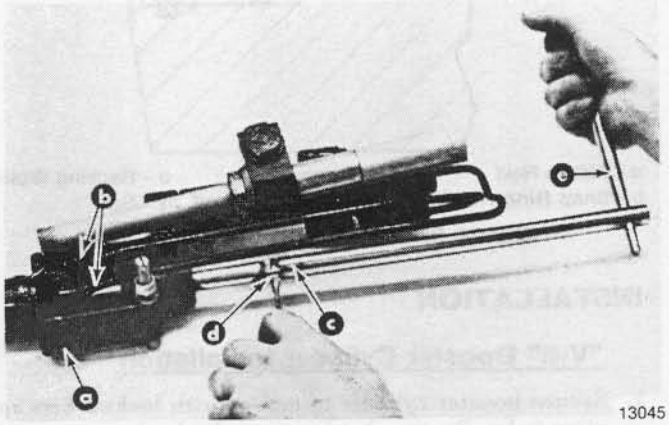
Figure 3. Removing Mounting Tube

4. Remove extension rod to cable end adaptor clevis pin and remove cable end adaptor. (Figure 1)
5. Remove Power Steering pump hydraulic hoses from control valve. (Figure 1) Cap hoses to prevent fluid drainage.
6. Loosen Power Steering unit set screw and loosen mounting tube jam nut with special 1⅜", 12-point crow's-foot (C-91-89035). (Figure 2)

7. Place a ⅛" (3.2mm) ID tube over extended end of locking spring and lift slightly to release spring from mounting tube. (Figure 3)
8. While lifting slightly on the locking spring, loosen and unthread mounting tube from Power Steering unit, using nut on end of tube (Figure 3) and 1⅛" deep well socket.
9. Remove mounting tube, then Power Steering unit from transom.

NOTE: In some installations, it will be necessary to remove extension rod from end of booster cylinder rod (because of engine compartment restrictions) BEFORE Power Steering unit can be removed from transom. Use instructions, following, which describe extension rod removal.

10. Inspect both the mounting tube and extension rod (Figure 4) for severe gouges or bent condition. If damage is present, replacement of mounting tube and extension rod is necessary.



a - Booster Cylinder Mounting Screws
b - Metal Pressure Tubes
c - Heat This Area
d - 7/16" Wrench
e - Brass Rod

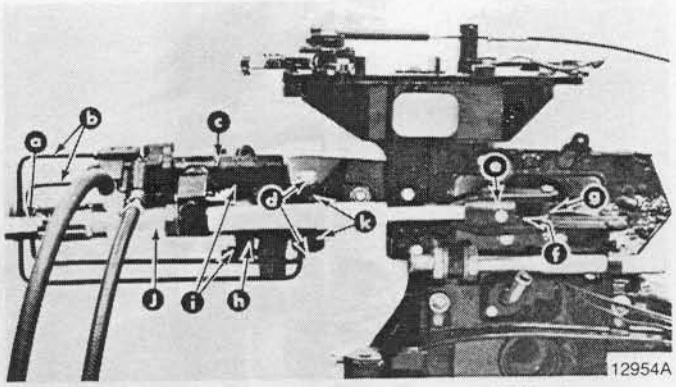
Figure 4. Removing Booster Cylinder

CAUTION: DO NOT use open flame to heat extension rod while in the engine compartment, as gas fumes could be present and an explosion could occur.

11. To remove extension rod from booster cylinder piston rod, heat (with a heat gun) area 1½" (38mm) from point where piston rod and extension rod are joined. Unthread extension rod from piston rod, using a 7/16" open end wrench and a brass rod, as shown in Figure 4.
12. Disconnect metal pressure lines from booster cylinder and remove booster cylinder mounting screws from bracket. Slide booster cylinder from bracket. (Figure 4)

"In-Line" Model Booster Cylinder Removal

1. Turn steering wheel full left.
2. Remove steering cable to cable guide end adaptor clevis pin and remove steering cable from cable guide tube. (Figure 5)



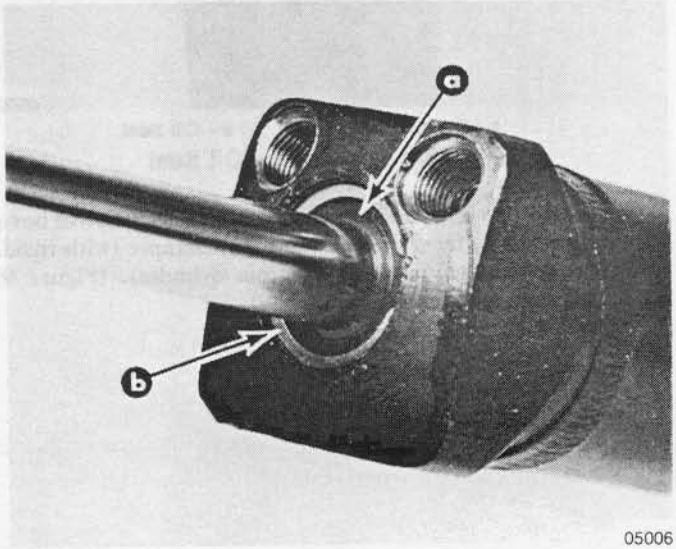
a - Steering Cable
b - Metal Pressure Tubes
c - Control Valve
d - Pivot Bolts
e - Cable End Adaptor
f - Flexloc Nut (Hidden)
g - Attaching Hardware
h - Booster Cylinder Retainer
i - Retainer to Swivel Mount Nuts and Lockwashers (One Hidden)

Figure 5. Removing Booster Cylinder

3. Remove attaching hardware that secures cable end adaptor to steering lever. (Retain hardware for reassembly.) (Figure 5)
4. Remove control valve as outlined under "Control Valve - Removal", preceding.
5. Remove pivot bolts. (Figure 5)
6. Remove Power Steering unit from transom.
7. Remove flexloc nut and washer from end of piston rod, then remove cable end adaptor from piston rod. (Figure 5)
8. Remove booster cylinder retainer to swivel mount allen head screws and lockwashers. (Figure 5)
9. Remove booster cylinder from mounting bracket.

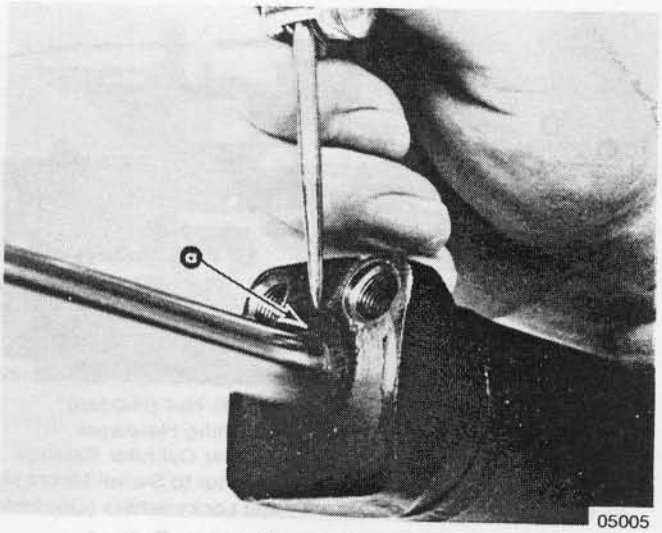
BOOSTER CYLINDER SEAL REPLACEMENT

1. Remove snap ring and scraper from cylinder and shaft. (Figure 6)
2. Pick scraper element from cylinder and remove backup washer. (Figure 7)



a - Snap Ring
b - Scraper

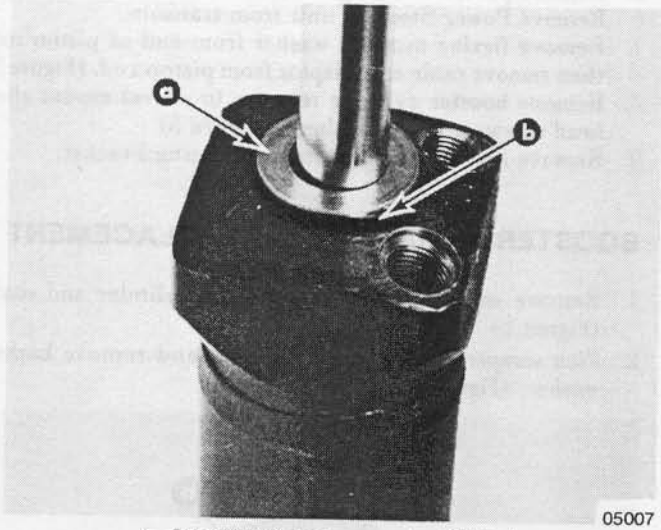
Figure 6. Snap Ring Location



a - Scraper Element

Figure 7. Removing Scraper Element

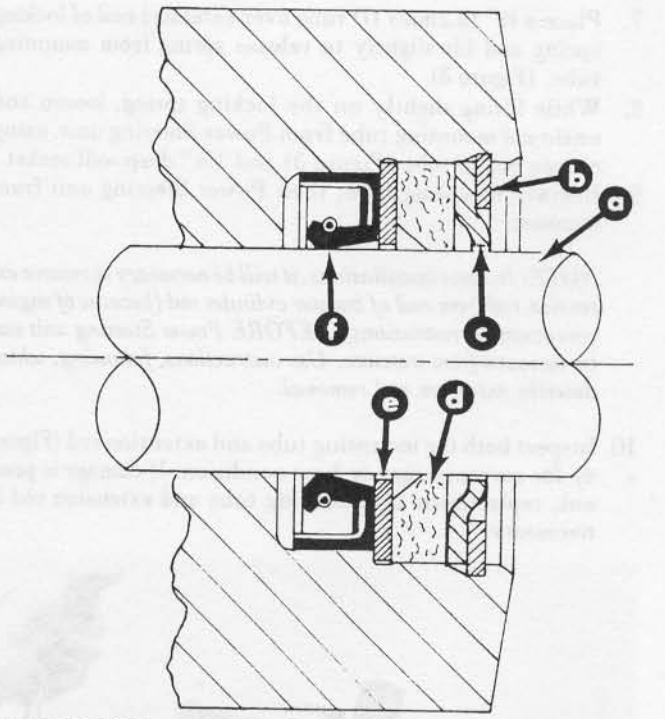
3. Pry oil seal from cylinder, being careful not to damage cylinder.
4. Use an appropriate mandrel to press in new oil seal (lip in toward cylinder) with backing washer. (Figures 8 and 9)



a - Backing Washer b - Oil Seal

Figure 8. Installing Oil Seal

5. Install new scraper element (with small ID portion of bevel facing away from cylinder) and new scraper (with inside raised portion facing away from cylinder). (Figure 9)
6. Install new snap ring. (Figure 9)



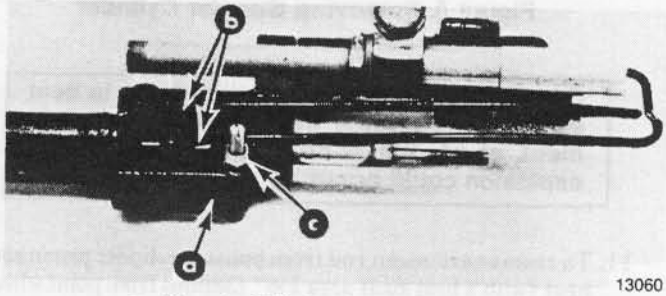
a - Piston Rod c - Scraper e - Backing Washer
b - Snap Ring Retainer d - Scraper Element f - Seal

Figure 9. Cross-Section of Seal Area

INSTALLATION

"V-8" Booster Cylinder Installation

1. Secure booster cylinder to mount with lockwashers and pivot bolts. Be sure that booster cylinder is positioned in mount as shown in Figure 10. Torque pivot bolts to specifications.



a - Booster Cylinder Mount
b - Metal Pressure Lines
c - Set Screw and Locknut (if Equipped)

Figure 10. Installing Booster Cylinder to Mount

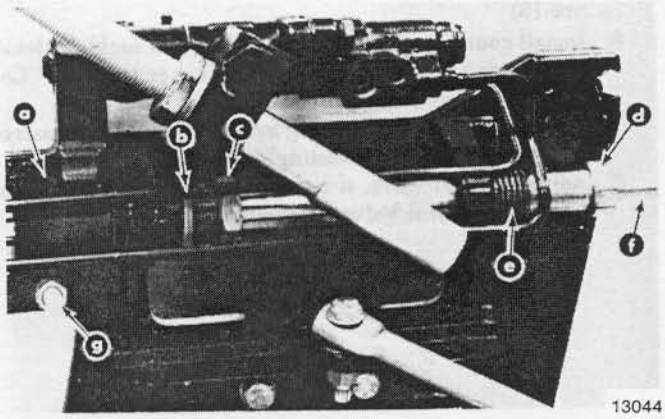
2. Connect metal pressure lines to booster cylinder and tighten to specifications. (Figure 10)
3. Clean threads on piston rod with a wire brush to remove old Loctite, then spray area with a coat of Locquic Primer Grade T and apply a few drops of No. 35 Loctite.

   NOTE: Because of engine compartment restrictions, it may be necessary to connect extension shaft to piston rod AFTER Power Steering unit is positioned on transom.

4. Clean internal threads of extension rod (if using original rod) with lacquer thinner to remove old Loctite and thread extension rod onto piston rod. Tighten extension rod to specification, using an aluminum or brass dowel and a 7/16" open end wrench. (Extension rod must "bottom-out" against shoulder on piston rod.) Wipe off excess Loctite, if present.

CAUTION: The mounting tube jam nut and washer MUST BE installed correctly (as described in next step), or Power Steering unit may loosen during operation.

5. Position Power Steering unit thru starboard transom mounting boss, concave washer (concave side facing port), jam nut (rounded side facing starboard), then thru port mounting boss. (Figure 11)



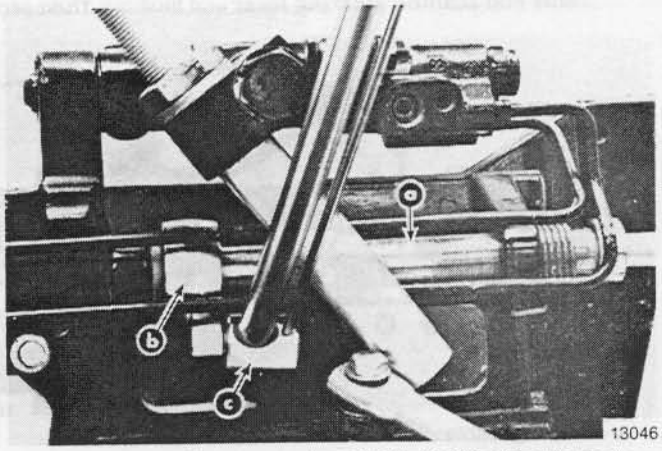
a - Power Steering Unit
b - Concave Washer (Concave Side Facing Port)
c - Jam Nut (Rounded Side Facing Starboard)
d - Mounting Tube and Nut
e - Locking Spring
f - Extension Rod
g - Set Screw (if Equipped)

Figure 11. Installing Power Steering Guide Tube

6. If not already installed, position retaining spring on mounting tube with 90° tang away from nut on end of tube. (Figure 11)

CAUTION: Special Lubricant 101 must be used to lubricate extension rod and mounting tube, or possible damage to steering system may occur due to lack of lubrication.

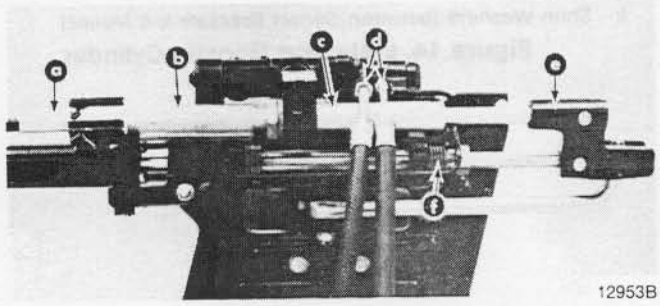
7. Lubricate extension rod and inside of mounting tube with Special Lubricant 101 and position mounting tube over extension rod and thru port mounting boss. Thread jam nut fully onto tube until it "bottoms-out". (Figure 11)
8. Thread mounting tube into Power Steering unit until jam nut bottoms against starboard transom boss.
9. If equipped with set screw (Figure 11), rotate Power Steering unit (by pushing on control valve) until it bottoms against transom plate, then turn adjusting screw in finger-tight against transom plate and secure with locknut.
10. Using a 1⅛" deep-well socket, torque mounting tube (using nut on end of tube) to 10 ft. lbs. (1.38mkg). Now torque mounting tube jam nut to 35-40 ft. lbs. (4.8-5.5mkg), using special 1⅜" - 12-point crow's-foot (C-91-89035). (Figure 12)



a - Mounting Tube
b - 1-3/8" - 12-Point Crow's-Foot
c - Torque Wrench

Figure 12. Torquing Mounting Tube Jam Nut

11. Rotate retaining spring on mounting tube so that 90° tang is against bottom side of port transom mounting boss, as shown in Figure 13.



a - Steering Cable
b - Guide Slide
c - Cable Guide Tube
d - Power Steering Pump Hydraulic Hoses
e - Cable End Adaptor
f - Locking Spring

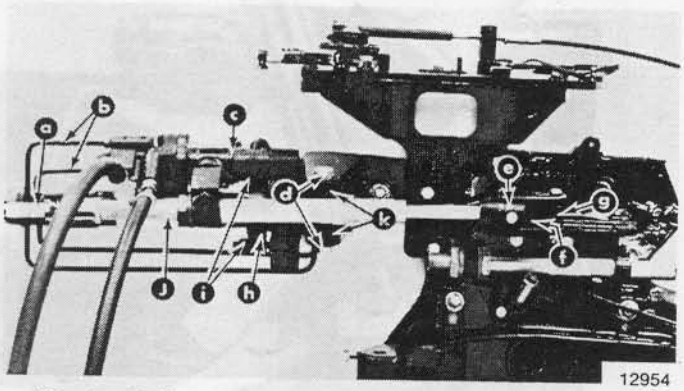
Figure 13. Power Steering Unit Installed

12. Install steering cable (with locking sleeve), Power Steering pump hydraulic hoses and cable end adaptor (refer to instruction under "Control Valve - Installation", preceding).
13. Fill and bleed Power Steering System according to instructions in "Filling and Bleeding", following.
14. Adjust control valve, if necessary, according to instructions in "Valve Balancing", following.

"In-Line" Booster Cylinder Installation

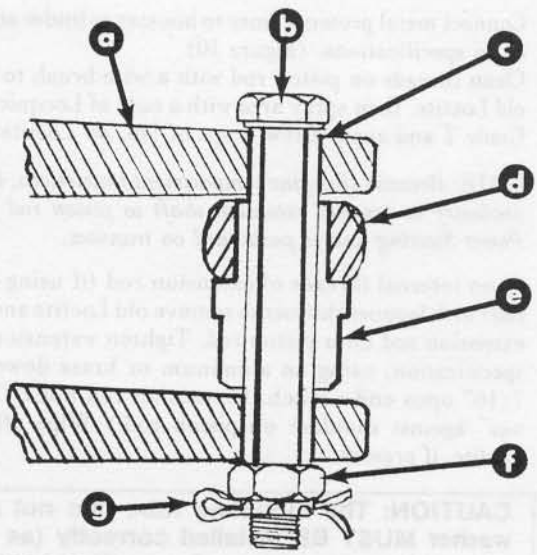
1. Insert piston rod thru swivel mount and position booster cylinder in bracket. (Figure 14)
2. Slide retainer over booster cylinder and secure retainer to swivel mount using allen head bolts, lockwashers and nuts. Tighten nuts to specifications. (Figure 14)

3. Install cable end adaptor over piston rod and secure with washer and flexloc nut. (Figure 14) Tighten nut to specification.
4. Position Power Steering unit in transom bracket and place shim washers between swivel mount and bracket on both sides. Install pivot bolts (with lockwashers) and tighten to specifications.
5. Apply a liberal coat of Special Lubricant 101 to bushing, sleeve and unthreaded portion of 2" (51mm) bolt. Attach cable end adaptor, steering lever and bushing, then secure



a - Steering Cable
b - Power Steering Pump Hydraulic Hoses
c - Control Valve
d - Pivot Screws
e - Cable End Adaptor
f - Flexloc Nut (Hidden)
g - Attaching Hardware
h - Booster Cylinder Retainer
i - Retainer to Swivel Mount Nuts and Lockwashers (One Hidden)
j - Guide Slide
k - Shim Washers (between Swivel Brackets and Mount)

Figure 14. Installing Booster Cylinder



a - Cable End Adaptor
b - Bolt
c - Sleeve
d - Steering Lever
e - Bushing
f - Castle Nut
g - Cotter Pin

Figure 15. Installing Steering Bolt

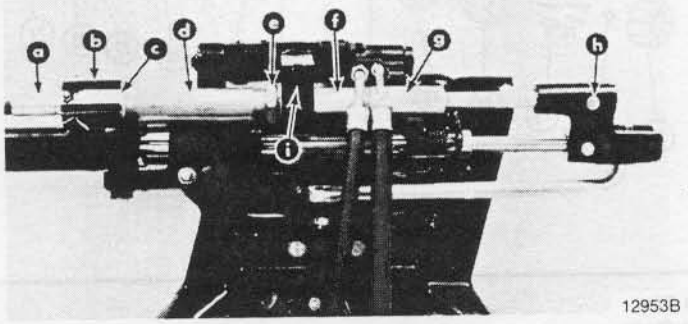
connection with long bolt and castle nut. Torque castle nut to specifications and back off until cotter pin can be installed. Install cotter pin and bend ends around bolt. (Figure 15)

6. Install control valve, steering cable (with locking sleeve) and Power Steering pump hydraulic hoses (refer to "Control Valve - Installation", preceding).
7. Fill and bleed Power Steering System according to instructions in "Filling and Bleeding", following.
8. Adjust control valve, if necessary, according to instructions in "Control Valve Balancing", following.

Cable Guide Tube

REMOVAL

1. Remove clevis pin, that secures steering cable in cable end adaptor, and remove cable end from adaptor. (Figure 1)



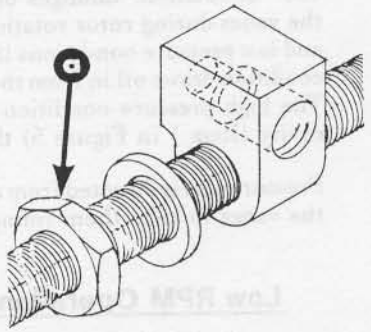
a - Steering Cable
b - Coupler Nut Locking Sleeve
c - Coupler Nut
d - Guide Slide
e - Guide Tube Mounting Nut
f - Sleeve Spacer
g - Guide Tube Mounting Sleeve
h - Clevis Pin
i - Adaptor Block to Control Valve Nut

Figure 1. Removing Cable Guide Tube

2. Remove coupler nut locking sleeve and loosen coupler nut. (Figure 1) DO NOT remove at this time.
3. Loosen large adaptor block to control valve nut. (Figure 1) While holding starboard side of cable guide tube and bracing other end of tube against transom, lightly hit head of nut to loosen adaptor block from control valve. Remove nut and steering guide tube assembly.
4. Remove coupler nut and guide tube from steering cable end and remove guide slide.
5. Place cable guide tube assembly in vise. Heat area, where spacer and guide tube mounting sleeve join (to break down Loctite), and unscrew guide tube mounting sleeve. Remove guide tube from adaptor block.
6. Heat guide tube mounting nut (to break down Loctite) and remove nut and washer.

INSTALLATION

NOTE: Be sure that mounting nut is installed on side of adaptor block, as indicated in illustration on left.

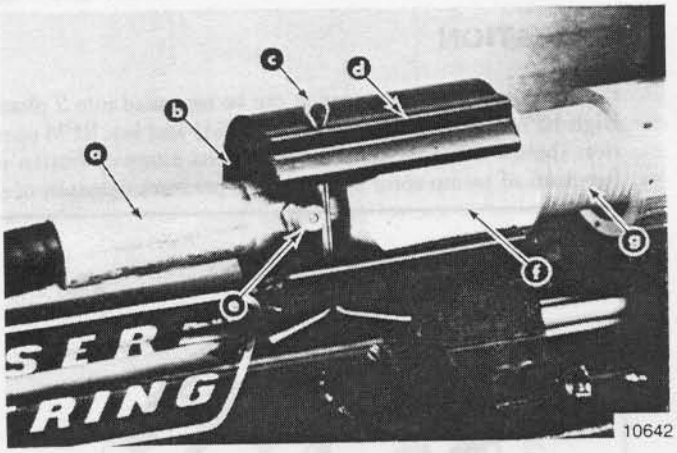


a - Mounting Nut

1. Insert guide tube thru adaptor block. Position concave washer over guide tube and thread mounting nut onto guide tube so that round side of nut faces large concave washer, and flat side of washer faces adaptor block.
2. Thread nut onto guide tube so that starboard end of tube is 6" ± ⅛" (15.2cm ± 3.2mm) (for V-8 Power Steering) or 4¼" ± ⅛" (10.8cm ±3.2mm) (for in-line Power Steering) from adaptor block. Back nut off enough to apply a few drops of Loctite "A" to threads of guide tube, then screw nut back into position that was previously determined.
3. Position sleeve over port side of guide tube. Apply a few drops of Loctite "A" to threads of guide tube and to inside of guide tube mounting sleeve. (Figure 1) Thread sleeve onto tube and torque to specifications.
4. Position cable guide tube adaptor block over control valve ball stud and secure block to stud with internally threaded nut and internal lockwasher. (Figure 1) Tighten nut to specifications.

IMPORTANT: Hold cable guide tube mounting sleeve (Figure 1) with a wrench to prevent guide tube from turning when tightening coupler nut in next step.

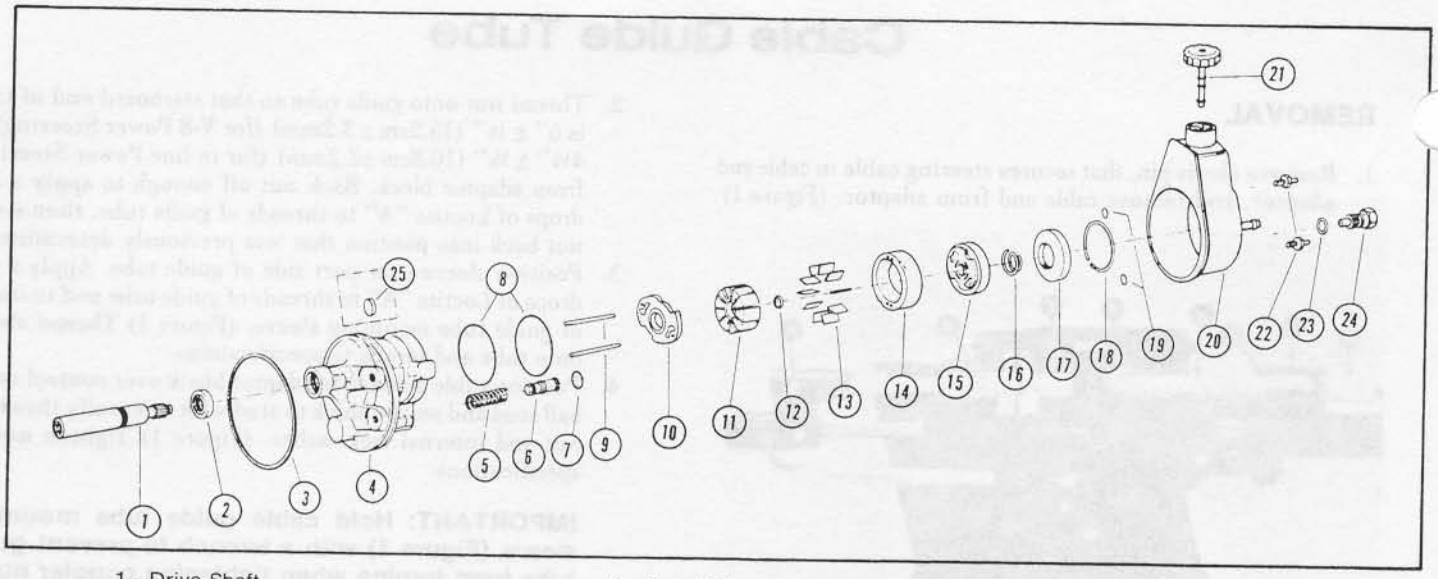
5. Position guide slide over guide tube, then apply Special Lubricant 101 to inside of cable guide tube and steering cable end and insert cable thru guide tube. (Figure 1) Thread coupler nut onto guide tube and position cable so that grease fitting is pointed outward. Tighten coupler nut to specification.
6. Install locking sleeve over steering cable coupler nut and secure with cotter pin, as shown in Figure 2. Be sure to install cotter pin between grease fitting and coupler nut.



a - Steering Cable (Ride-Guide)
b - Rubber Bumper
c - Cotter Pin
d - Locking Sleeve
e - Grease Fitting
f - Cable Coupler Nut
g - Cable Guide Tube

Figure 2. Coupler Nut Locking Sleeve Installed

7. Attach steering cable end to cable end adaptor with clevis pin and secure with cotter pin. (Figure 1) Be sure to spread both ends of cotter pin.
8. Fill and bleed Power Steering System according to instructions, following.



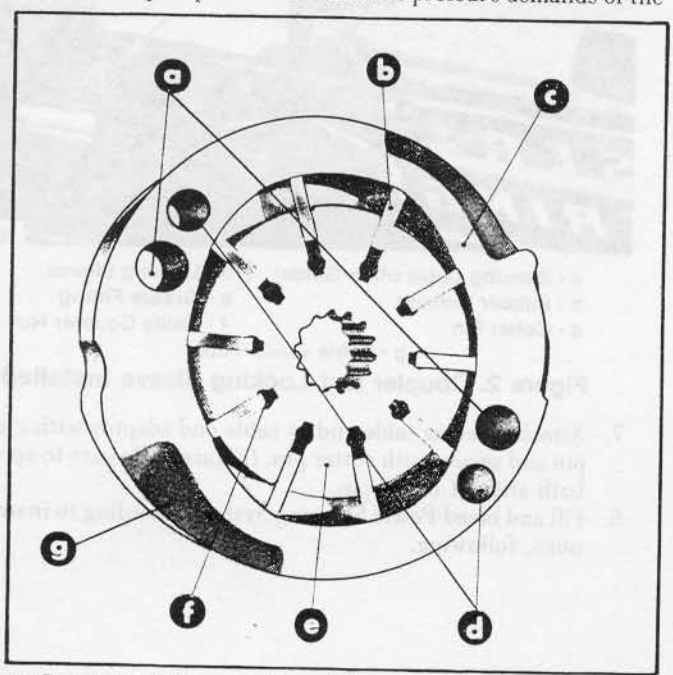
1 - Drive Shaft
2 - Drive Shaft Seal
3 - "O" Ring Seal (Housing)
4 - Pump Housing Assembly
5 - Flow Control Spring
6 - Control Valve Assembly
7 - "O" Ring Seal (Housing)
8 - "O" Ring Seal (Pressure and End Plate)
9 - Dowel Pin
10 - Thrust Plate
11 - Pump Rotor
12 - Shaft Retaining Ring
13 - Pump Vane
14 - Pump Ring
15 - Pressure Plate
16 - Pressure Plate Spring
17 - End Plate
18 - End Plate Retaining Ring
19 - "O" Ring Seal (Housing to Stud)
20 - Pump Reservoir Assembly
21 - Reservoir Cap Assembly
22 - Stud or Bolt
23 - "O" Ring Seal (Fitting Assembly)
24 - Fitting Assembly
25 - Magnet

Figure 3. Power Steering Pump Assembly

Power Steering Pump

OPERATION

Power Steering pump operation can be separated into 2 phases: High RPM operation (above 1000 RPM) and low RPM operation (below 1000 RPM). Power Steering pump operation is a function of pump rotor RPM and the pressure demands of the Power Steering unit (on transom). An internal flow control valve recognizes these conditions and compensates for them. The flow control valve incorporates a relief valve (Item 6 in Figure 5) to regulate maximum pressure.



a - Cross Over Holes (Pressure Port)
b - Vane
c - Pump Ring
d - Dowel Pin Holes
e - Rotor
f - Under Vane Hole
g - Intake Port

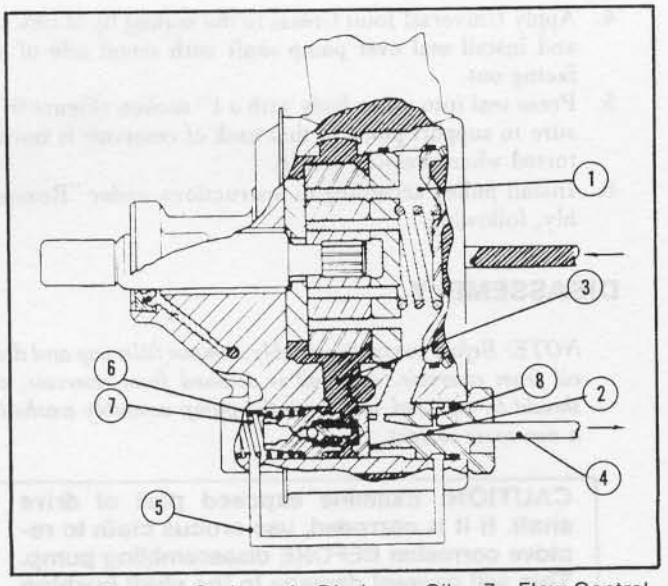
Figure 4. Pump Ring and Rotor

Figure 4 illustrates pump ring and rotor assembly. As the shaft turns the rotor, the vane tips follow the inner cam surface of the pump ring, moving outward and inward twice during each revolution. This results in a complete pumping cycle every 180° of rotation. Changes of volume in the spaces between the vanes during rotor rotation cause alternate high pressure and low pressure conditions in these spaces. The low pressure condition draws oil in from the reservoir thru the intake ports. The high pressure condition expels oil under pressure into cavity (Item 1 in Figure 5) thru the pressure ports.

Pressure also is directed from cavity (Item 1 in Figure 5) under the vanes to keep them riding against the pump ring.

Low RPM Operation (Figure 5)

During normal operation, discharge oil pressure (Item 4 in Figure 5) is slightly lower than oil pressure in the cavity (Item 1). The drop in pressure occurs as oil flows thru the orifice (Item 2). Because of the venturi effect, pressure in orifice (Item 8) also is reduced. As pump RPM increases (up to 1000 RPM), discharge oil flow increases, thus causing progressively lower pressure in the orifice (8). Orifice (8) is connected by passage (5) to the control valve (6), therefore, pressure at the spring end of the control valve is reduced. The flow control valve moves away from the discharge fitting. The force, that is exerted by the flow control spring (7), stops the control valve from opening the pump bypass port (3).



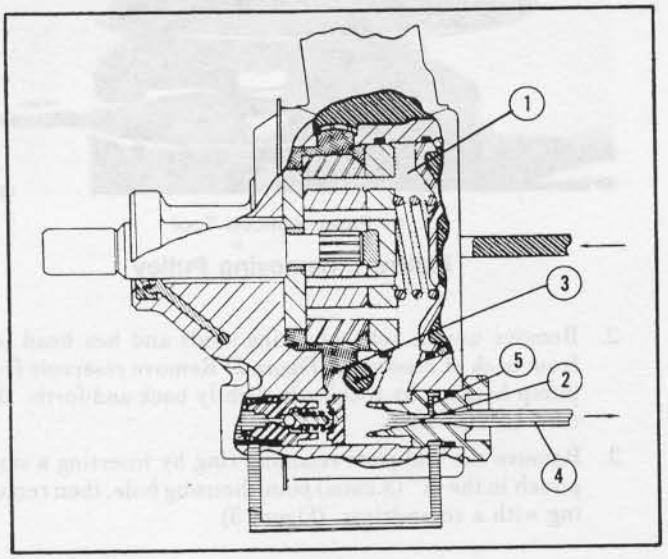
1 - High Pressure Cavity
2 - Flow Control Orifice
3 - Pump Bypass Port
4 - Discharge Oil
5 - Oil Passage
6 - Control Valve
7 - Flow Control Spring
8 - Orifice

Figure 5. Low RPM Operation

When there is a Power Steering unit demand (turning steering wheel), fluid is redirected in the system. Discharge oil flow is reduced for an instant because of increased resistance. As the flow decreases, the pressure in the orifice (8) increases, thus allowing the flow control spring (7) to push the control valve closer to the discharge fitting. This reduces the volume in the cavity (1), thereby increasing pressure in the cavity (1). As the pressure increases, flow increases, once again causing the flow control valve to remain in its new position.

High RPM Operation (Figure 6)

Pump operation during high RPM (above 1000 RPM) is much like low RPM operation, however, the flow thru orifice (Item 2 in Figure 6) is greater. This causes low enough pressure in orifice (Item 8) to allow the control valve to open the bypass port (3). As pump RPM increases, the control valve moves further away from the discharge fitting. Because more oil is allowed to bypass as speed increases, discharge oil flow (4) remains relatively constant.



1 - High Pressure Cavity
2 - Flow Control Orifice
3 - Pump Bypass Port
4 - Discharge Oil
5 - Orifice

Figure 6. High RPM Operation

When there is demand by the Power Steering unit, the operation is similar to that at low RPM, however, when pressure is required, the flow control does not allow as much bypass.

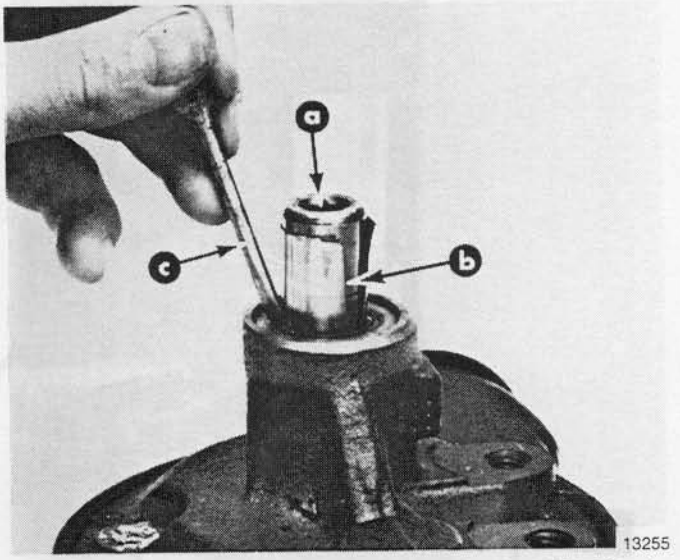
REMOVAL

1. Disconnect hoses at pump. When hoses are disconnected, secure ends in a raised position to prevent loss of oil. Cap ends of hoses to prevent dirt from entering.
2. Install 2 caps or plugs at hose fittings to prevent loss of oil from pump.
3. Loosen necessary bolts to loosen belt tension.
4. Remove pump belt.
5. Remove pump and mounting brace from engine.

COMMON REPAIRS

Servicing of Flow Control Valve

1. Drain fluid from pump.
2. Remove union and withdraw flow control valve and spring with a magnet.
3. Check for dirt or burrs. Flow control valve must slide freely in housing.
4. Check cap screw in end of valve for looseness. Tighten if loose, being careful not to damage machined surfaces.
5. To install flow control valve, install spring and flow control valve (cap screw end first).
6. Install union with new "O" ring and tighten securely.



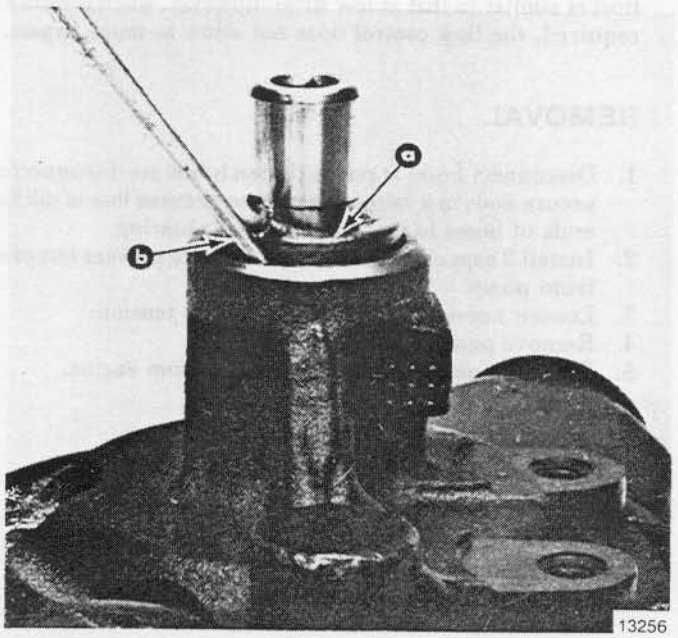
a - Pump Shaft
b - Shim Stock
c - Cut Seal With Chisel

Figure 7. Cutting Pump Seal

Pump Shaft Oil Seal Replacement (without Disassembling Pump)

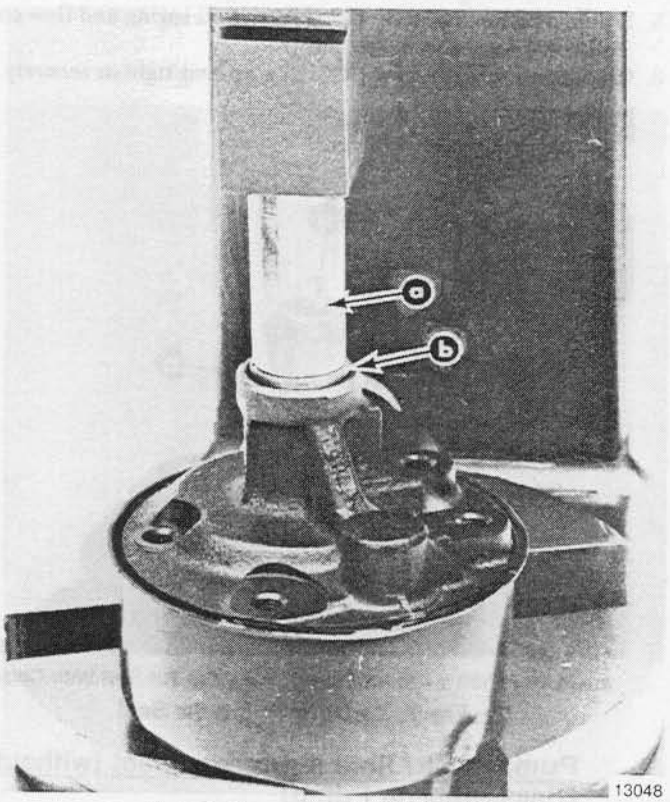
1. Remove the pump pulley as described under "Disassembly", following, then bend a piece of .005" (0.12mm) shim stock [approximately 2½" (63.5mm) long] into a cylindrical shape. Push the shim stock past the seal until it bottoms in pump body. (Figure 7)

2. Cut metal body of seal with a small chisel and tear metal body approximately 1" (25mm).
3. Force an awl between pump body and the OD of seal to collapse seal, then pry seal from pump body. (Figure 8) Remove shim stock.



a - Torn Seal
b - Force between Pump Housing and Seal, then Pry Seal Out

Figure 8. Removing Pump Seal



a - 1" Socket b - Seal (Metal Side Up)

Figure 9. installing Pump Shaft Seal

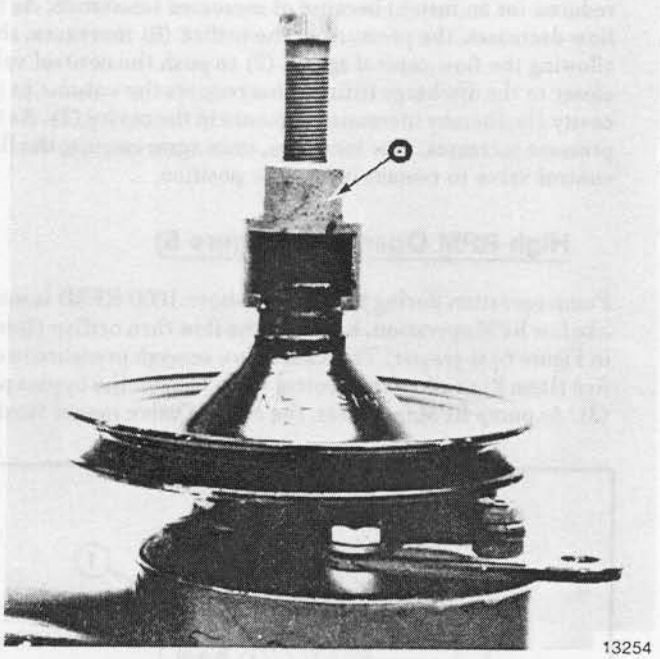
4. Apply Universal Joint Grease to the sealing lip of new seal and install seal over pump shaft with metal side of seal facing out.
5. Press seal into pump body with a 1" socket. (Figure 9) Be sure to support pump so that back of reservoir is not distorted when pressing seal in.
6. Install pulley according to instructions under "Reassembly, following.

DISASSEMBLY

NOTE: Before pump disassembly, remove filler cap and drain oil from reservoir. After oil is drained from reservoir, cap should be replaced, and the entire pump assembly washed in a non-toxic solvent.

CAUTION: Examine exposed part of drive shaft. If it is corroded, use crocus cloth to remove corrosion BEFORE disassembling pump. This will prevent damage to the shaft bushing when removing shaft from housing later.

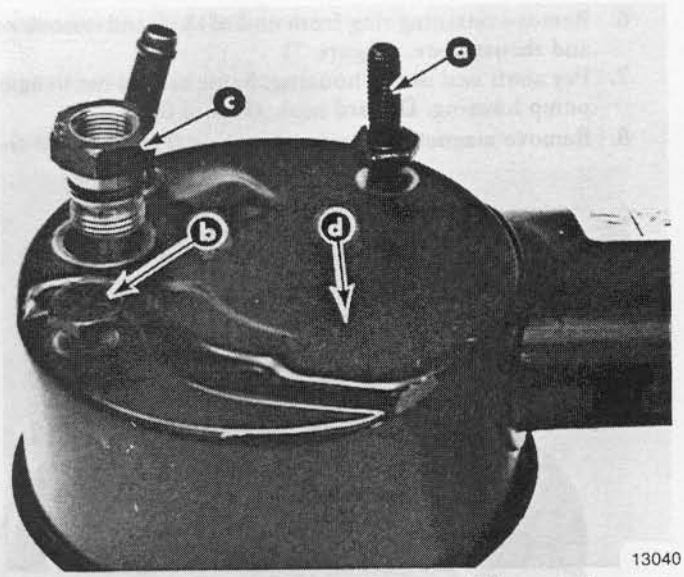
1. Remove pulley, using Kent-Moore Pulley Removal Tool (J-25034 or J-21239-1). (Figure 1)



a - Pulley Removal Tool

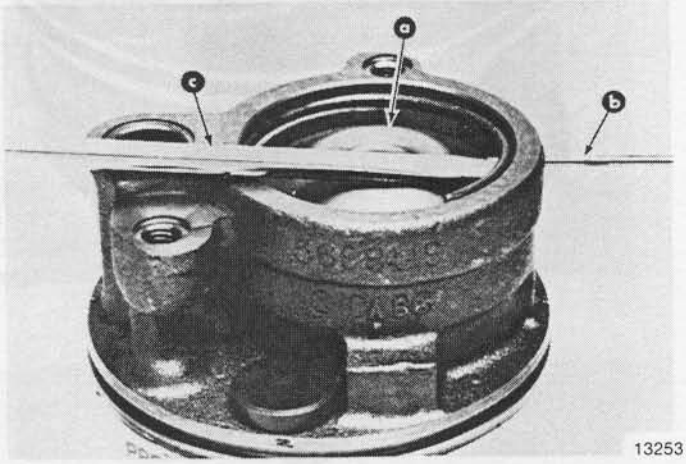
Figure 1. Removing Pulley

2. Remove union, both mounting studs and hex head bolt from back of reservoir. (Figure 2) Remove reservoir from pump housing by rocking it slightly back-and-forth. Discard all "O" rings.
3. Remove the end plate retaining ring by inserting a small punch in the ⅛" (3.2mm) pump housing hole, then removing with a screwdriver. (Figure 3)



a - Mounting Stud b - Hex Head Bolt c - Union d - Reservoir

Figure 2. Removing Reservoir from Pump Housing



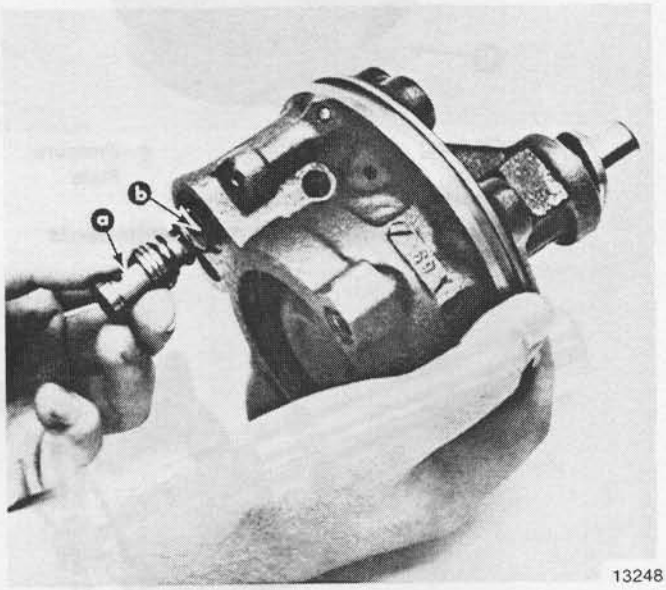
a - End Plate Retaining Ring
b - Small Punch in 1/8" Pump Housing Hole
c - Screwdriver

Figure 3. Removing End Plate Retaining Ring

4. Remove end plate and spring. If end plate does not sit above housing level after removing retaining ring, then a slight rocking action or a light tapping with a soft hammer will free the plate. (Figure 4) Remove "O" ring from pump housing.
5. Invert the pump housing, remove flow control valve (Figure 5) and tap on end of pump shaft to remove pressure plate, shaft, pump ring, vanes and rotor. (Figure 6) Remove "O" ring from pump housing.

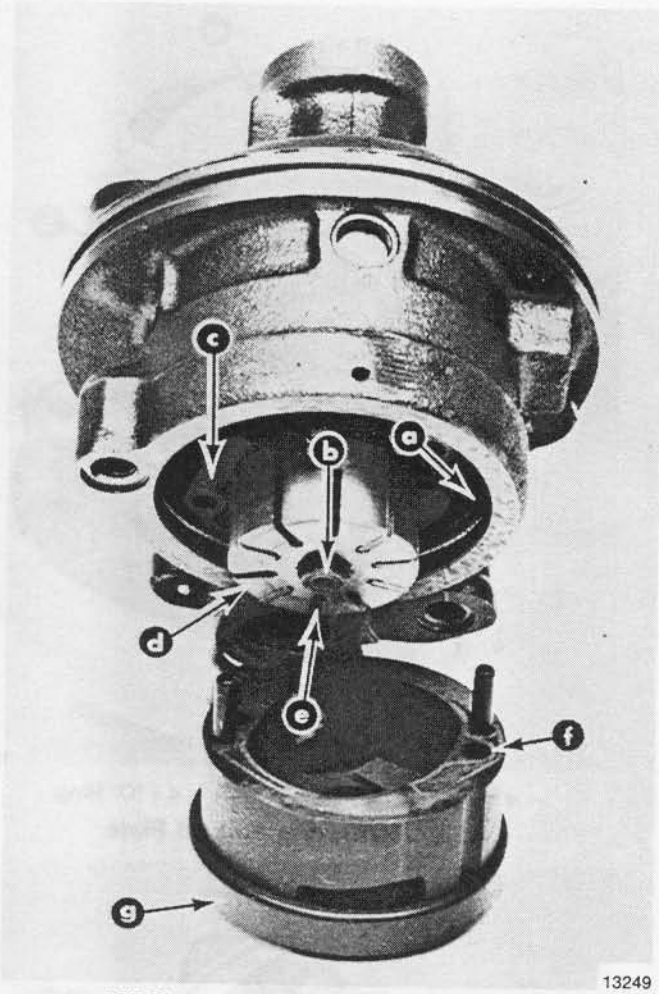
a - End Plate b - Spring c - "O" Ring

Figure 4. Removing End Plate



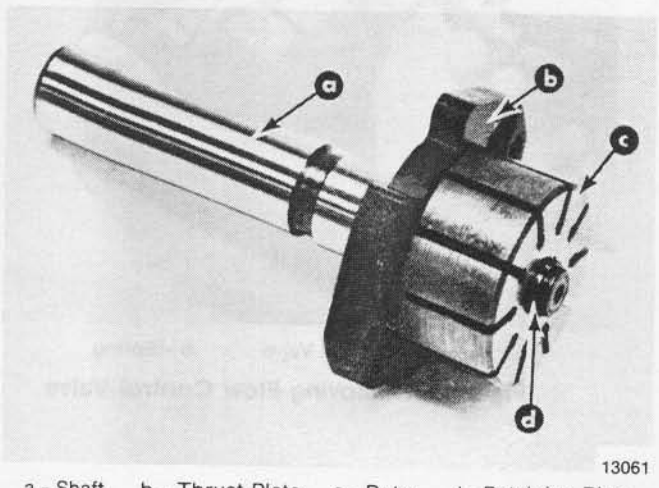
a - Flow Control Valve b - Spring

Figure 5. Removing Flow Control Valve



a - "O" Ring
b - Shaft
c - Thrust Plate
d - Rotor
e - Vanes
f - Pump Ring
g - Pressure Plate

Figure 6. Removing Pump Components



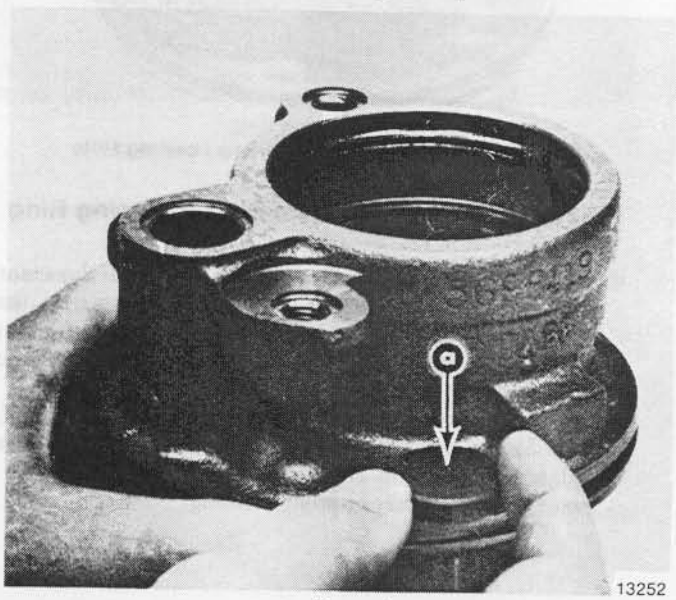
a - Shaft b - Thrust Plate c - Rotor d - Retaining Ring

Figure 7. Removing Rotor and Thrust Plate from Shaft

6. Remove retaining ring from end of shaft and remove rotor and thrust plate. (Figure 7)
7. Pry shaft seal out of housing, being careful not to damage pump housing. Discard seal. (Figure 8)
8. Remove magnet from pump housing (Figure 9) and clean.

a - Seal

Figure 8. Removing Pump Seal



a - Magnet

Figure 9. Removing Magnet

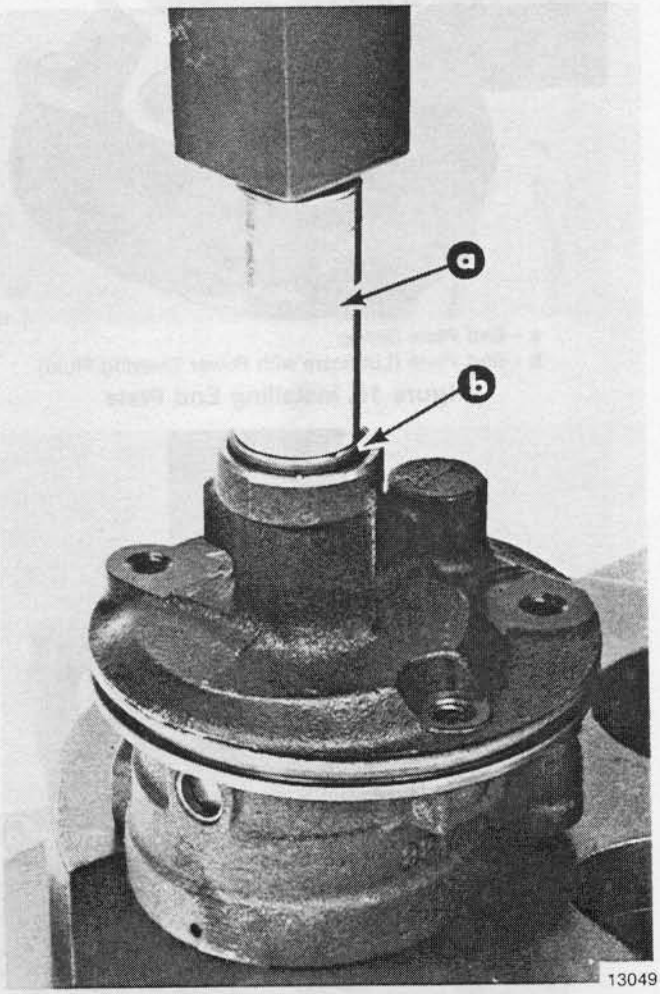
INSPECTION

After cleaning all metal parts in a non-toxic solvent, check the following:

1. Flow control valve must slide freely in housing bore. If sticking is observed, check for dirt and burrs.
2. Check cap screw in the end of flow control valve for looseness and tighten if necessary, being careful not to damage machined surfaces.
3. Be sure that pressure plate and pump plate surfaces are flat and parallel with pump ring.
4. Check pump housing for cracks and soft plug for looseness (a condition that causes excessive foaming).
5. Make sure that vanes are installed so that rounded edge is toward pump ring and that they move freely in rotor slots.
6. Check drive shaft for worn splines, cracks and worn bearing surface.

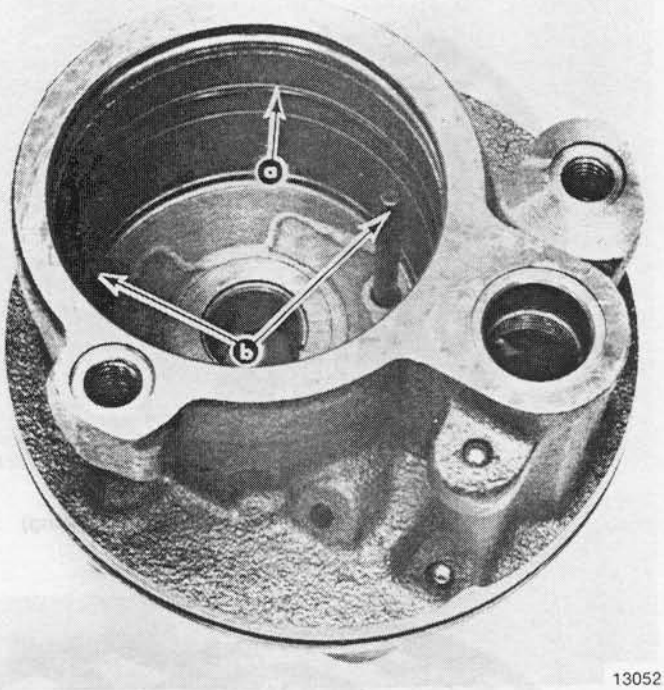
REASSEMBLY

NOTE: All references to Power Steering fluid refer to Automatic Transmission Fluid ATF type F or Dexron. Also obtain and install a new seal kit No. 5688044 from a local GM automotive dealer when reassembling pump.



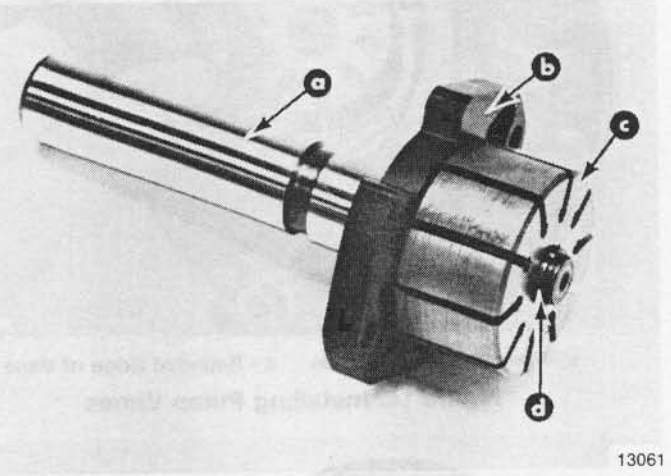
a - 1" Socket b - Seal

Figure 10. Installing Pump Shaft Seal



a - Pressure Plate "O" Ring b - Dowel Pins

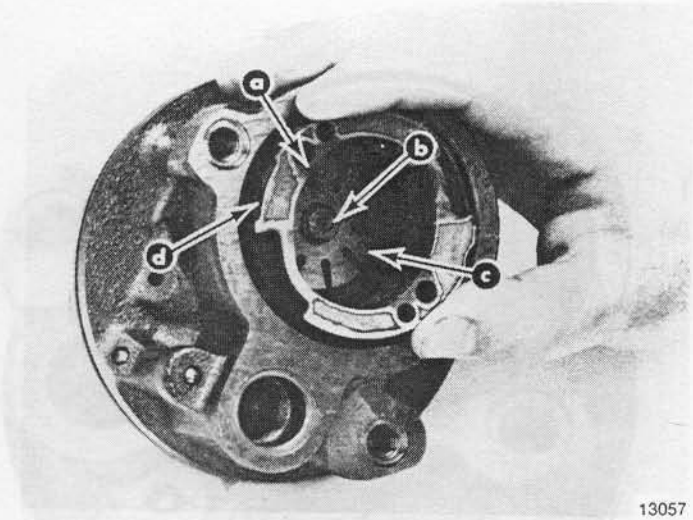
Figure 11. Installing Dowel Pins



a - Shaft c - Rotor
b - Thrust Plate d - Snap Ring

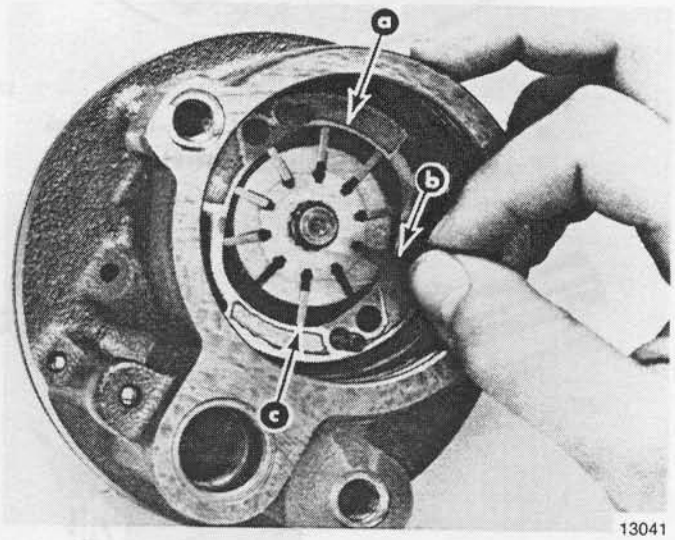
Figure 12. Installing Rotor to Pump Shaft

1. Install a new pump shaft seal, using a 1" socket with an arbor press or hammer. (Figure 10) Be careful not to distort seal by using excessive force.
2. Lubricate new pressure plate "O" ring with Power Steering fluid and install in third groove from rear of housing. Install both dowel pins. (Figure 11)
3. Insert shaft thru thrust plate and rotor (countersunk side is toward thrust plate) and secure with snap ring. (Figure 12)
4. Insert shaft in housing, making sure that the thrust plate slides properly over dowel pins. Now install pump ring with the arrow toward rear of housing. (Figure 13)



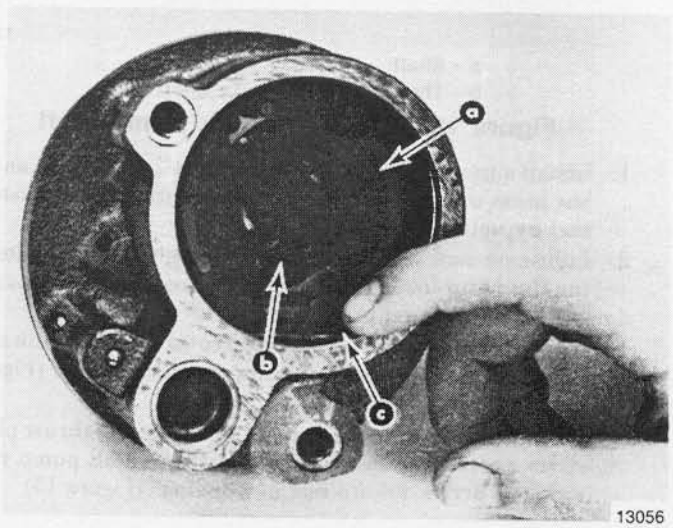
a - Pump Ring c - Rotor
b - Shaft d - Arrow (toward Rear of Housing)

Figure 13. Installing Pump Ring



a - Pump Ring b - Vanes c - Rounded Edge of Vane

Figure 14. Installing Pump Vanes



a - Pressure Plate b - Circular Depression for Spring
c - "O" Ring (Place in Second Groove from Rear of Housing

Figure 15. Installing Pressure Plate

5. Install all 10 vanes in rotor slots so that rounded edges of vanes point toward pump ring (outward). (Figure 14) Vanes must slide freely.
6. After lubricating pressure plate with Power Steering fluid, install plate on dowel pins with circular depression for spring toward rear of housing. (Figure 15)
7. Lubricate end plate "O" ring with Power Steering fluid and install in second groove from rear of housing. (Figure 15)
8. Place end plate spring in groove that is provided in pressure plate. Lubricate end plate with Power Steering fluid (DO NOT damage "O" ring) and press into housing with an arbor press. (Figure 16) Depress only far enough to enable retaining ring to seat in groove.

a - End Plate Spring
b - End Plate (Lubricate with Power Steering Fluid)

Figure 16. Installing End Plate

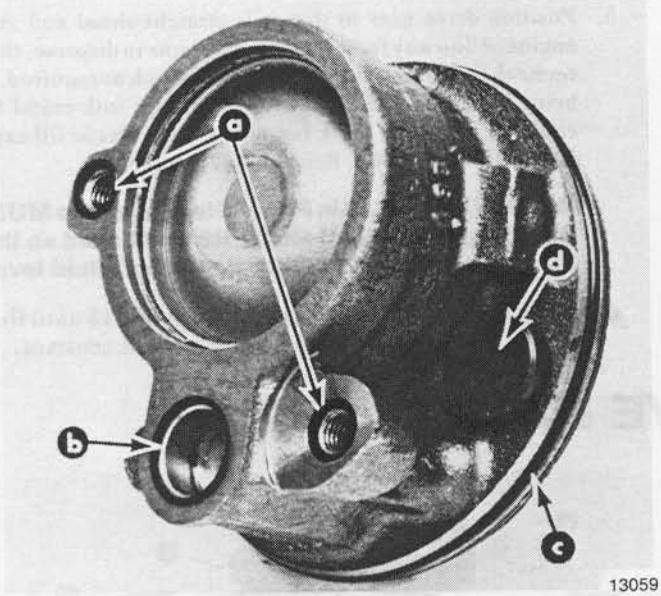
a - Pump Housing Hole b - Retaining Ring

Figure 17. Installing End Plate Retaining Ring

9. Install end plate retaining ring so that gap in ring is away from ⅛" (3.2mm) pump housing hole. (Figure 17)
10. Place flow control valve spring in hole first, then insert flow control valve with screened end toward front of housing. (Figure 18)

a - Spring b - Flow Control Valve (Screened End in Hole First)

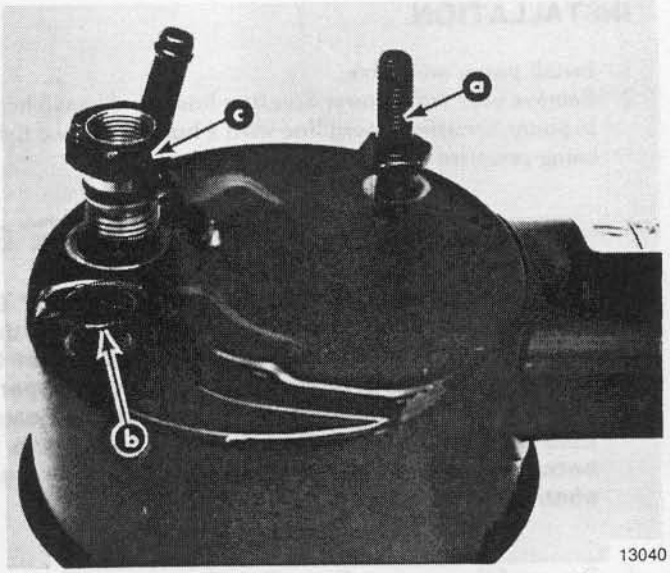
Figure 18. Installing Flow Control Valve



a - Stud Seals c - Reservoir "O" Ring
b - Union Seal d - Magnet

Figure 19. Installing Pump Seals and "O" Ring

11. Install new union seal and stud seals in countersunk holes. Lubricate new reservoir "O" ring with Power Steering fluid and install in groove on pump housing. Install magnet in location shown in Figure 19.
12. Lubricate inside edge of reservoir and install on pump housing while aligning holes at the same time.
13. Insert both reservoir retaining bolt and mounting stud (insert stud in hole from which originally removed) and tighten to specifications. (Figure 20)
14. Install new "O" ring on union and lubricate with Power Steering fluid. Make sure that "O" ring is in groove next to

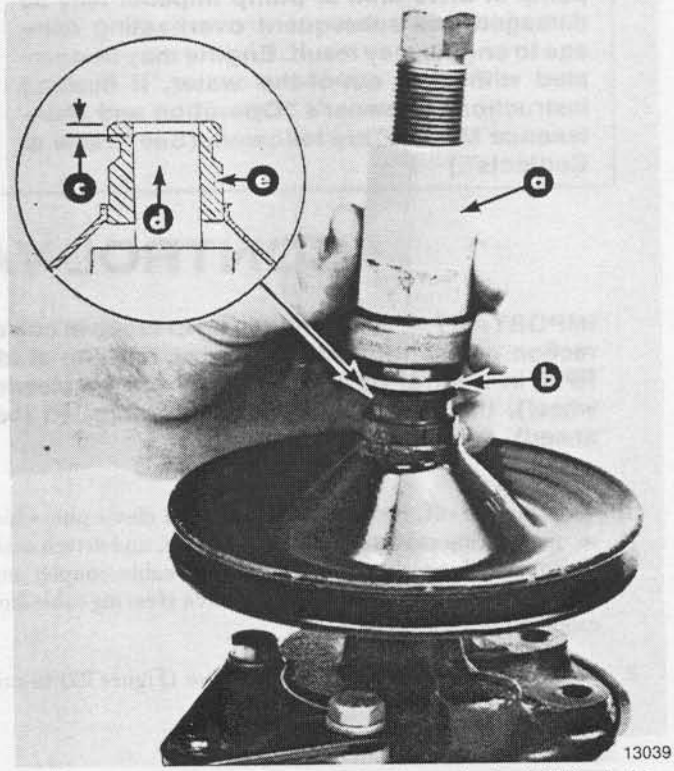


a - Mounting Stud c - Union (with "O" Ring in Place)
b - Reservoir Retaining Bolt

Figure 20. Installing Reservoir to Pump Housing

hex head. Insert union in flow control valve hole in back of reservoir and tighten to specification.

15. Install pump mounting brace to face (if removed). Install pulley to shaft with Pulley Installation Tool (C-91-71803-A1) and appropriate side of Spacer (B-23-91834). Pulley should be installed so that end of pulley is .135" (3.4mm) (for in-line engines) or .200" (5.1mm) (for V-8 engines) above the pump shaft. (Figure 21)



a - Pulley Installation Tool c - This Dimension Is .135" for In-Line Engines or .200" for V-8 Engines
b - Spacer
d - Pump Shaft e - Pulley

Figure 21. Installing Pump Pulley

INSTALLATION

1. Install pump on engine.
2. Remove caps from Power Steering hoses and install hoses to pump, securing return line with a hose clamp and tightening pressure line fitting to specifications.
3. Install belt over engine pulley and pump pulley.
4. Adjust belt tension so that the belt depresses ¼" (6.4mm) at a point midway between the pulleys. Tighten adjusting bolts.
5. Fill and bleed Power Steering System according to instructions, following.

FILLING and BLEEDING

IMPORTANT: Power Steering system MUST BE filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering System to become spongy, which may result in poor boat control.

1. Remove filler cap from Power Steering pump and look into pump reservoir. If fluid is not visible, add automatic transmission fluid (ATF) Type F or Dexron, as required, until fluid covers casting in pump reservoir.
2. Turn steering wheel back-and-forth to end of travel in each direction, then recheck oil level and add fluid, as required, until it again covers casting in reservoir.

CAUTION: DO NOT operate engine without cooling water flowing thru seawater pickup pump in drive unit, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out-of-the water, if flushing instructions in owner's "Operation and Maintenance Manual" are followed. (See "Table of Contents".)

SAFETY WARNING: DO NOT check fluid level while engine is running, as hands and clothing could get caught in V-belts and pulleys.

3. Install fill cap, start engine and run at idle speed. Turn steering wheel back-and-forth to end of travel in each direction several times, then position steering wheel so that drive unit is straight-ahead and stop engine. Allow any foam in pump reservoir to disperse, then check fluid level with dipstick (attached to fill cap). Add fluid, as required, to bring level up to "Add" mark (on pumps with metal fill cap) or "Full-Cold" mark (on pumps with plastic fill cap). DO NOT OVERFILL. Reinstall fill cap.
4. Restart engine and run at fast idle for approximately 10 minutes. During this time, turn steering wheel back-and-forth to end of its travel in each direction several times.
5. Position drive unit so that it is straight-ahead and stop engine. Allow any foam in pump reservoir to disperse, then recheck fluid level with dipstick. Add fluid, as required, to bring level up to "Full" mark (on pumps with metal fill cap) or "Full-Hot" mark (on pumps with plastic fill cap). DO NOT OVERFILL. Reinstall fill cap securely.

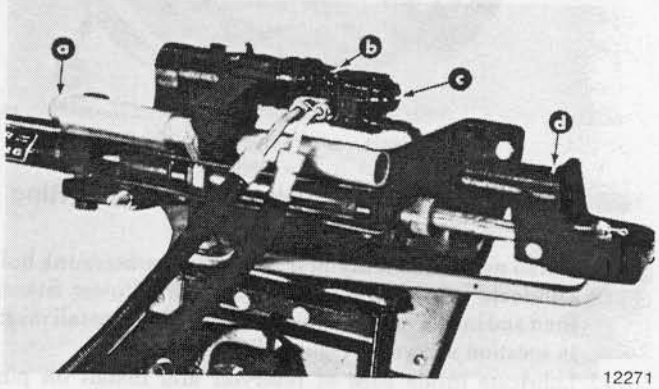
   IMPORTANT: Fluid in Power Steering pump MUST BE hot, and drive unit MUST BE positioned so that it is straight-ahead to accurately check fluid level.
6. If fluid was foamy in Step 5, repeat Steps 4 and 5 until fluid no longer becomes foamy and level remains constant.

CONTROL VALVE BALANCING

IMPORTANT: If drive unit tends to creep in one direction or the other (with engine running at idle RPM in neutral gear and hands off the steering wheel), the control valve must be adjusted (balanced), as explained, following.

1. With engine off, remove cotter pin and clevis pin, which secure steering cable to cable end adaptor, and detach cable. Remove locking sleeve from steering cable coupler nut, then unthread coupler nut and remove steering cable from cable guide tube. (Figure 22)
2. Remove dust cover from control valve (Figure 22) to gain access to adjusting nut.

SAFETY WARNING: When turning adjusting nut (in next step), use long extension shaft on socket to prevent placing hands in a position where they could be injured by cable end adaptor movement.



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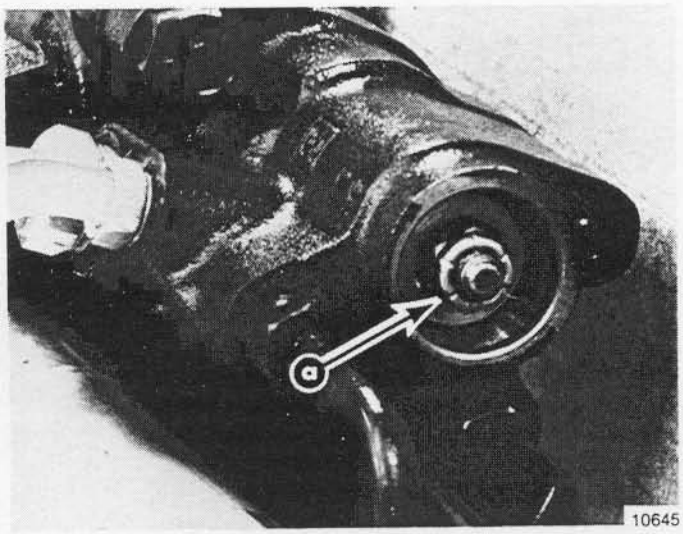
a - Steering Cable Removed
b - Control Valve
c - Dust Cover
d - Cable End Adaptor

Figure 22. Steering Cable Removed for Valve Balancing

IMPORTANT: DO NOT move adjusting nut more than necessary (in next step), as excessive movement could cause nut to lose its friction locking quality.



a - Adjusting Nut

Figure 23. Adjusting Nut Location

3. Start engine and adjust adjusting nut (Figure 23), as follows:
   a. If cable end adaptor moves toward right (starboard), turn adjusting nut clockwise until adaptor just begins to move toward left (port). Now turn nut counterclockwise to exactly one-half the rotation needed to change direction of cable end adaptor movement.
   b. If cable end adaptor moves toward left (port), turn adjusting nut counterclockwise until adaptor just begins to move toward starboard. Now turn nut clockwise to exactly one-half the rotation needed to change direction of cable end adaptor movement.
4. Turn engine off. Reinstall steering cable, as explained under "Control Valve - Installation", preceding.

SAFETY WARNING: Steering cable outer casing MUST BE free to move back-and-forth for Power Steering to function properly. DO NOT fasten any wires, cables or other items to steering cables, as this may prevent them from moving.

5. Restart engine and observe drive unit. If drive unit still creeps, an external tension on the steering cable is present, either as a pulling or pushing force. The steering cable MUST BE free to move.
6. After valve has been adjusted correctly, place U-joint Lubricant on end of valve and reinstall dust cap.

I-DRIVE
Service Bulletins

NOTICE
Enclosed Service Bulletins are changes that occurred to product after Service Manual was published.

SECTION 7

service bulletin

mercruiser

STERN DRIVES/INBOARD ENGINES

NUMBER: 82-4
DATE: 6/1/82

A. Checking Stern Drive Unit Seawater Pickup Pump Output - Mer-Cruiser I Stern Drives
B. Insufficient Water Flow From MC-I Drive Unit Seawater Pickup Pump Troubleshooting Chart

CIRCULATE TO:
SERVICE MANAGER
PARTS MANAGER
MECHANICS

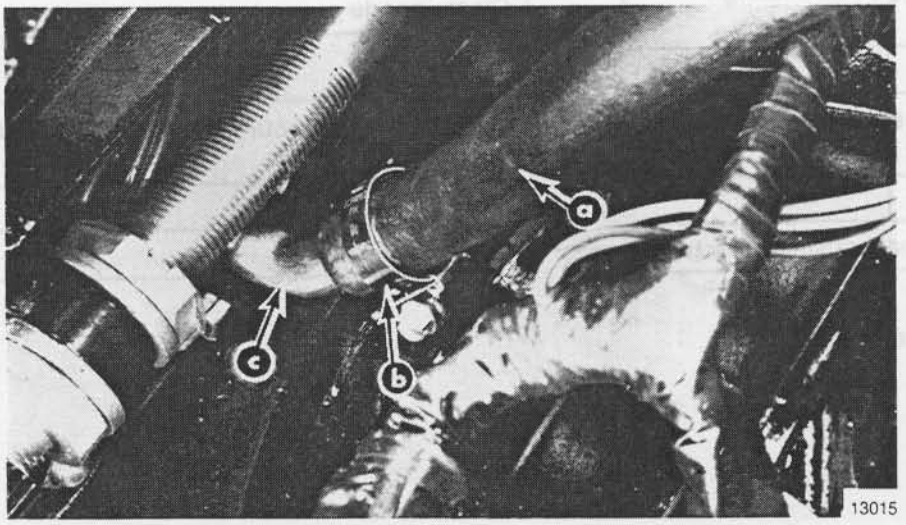
A. CHECKING STERN DRIVE UNIT SEAWATER PICKUP PUMP OUTPUT - MERCRUISER I STERN DRIVES

The following test can be used when troubleshooting an overheating condition to determine if cause is due to insufficient water flow from seawater pickup pump in drive unit.

IMPORTANT: The following information should be observed before proceeding with test:

- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and a water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy in which it is performed. An error in setting the engine RPM, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within 1 second. A 6 quart (or larger) capacity container calibrated in ¼ quart increments should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem. If test results are questionable or if adequate output is indicated but cause for overheating condition cannot be found, refer to the troubleshooting chart, following, and check the items indicated.**

1. Remove water inlet hose, which runs between gimbal housing water tube and engine (Figure 1), and replace with another hose of same diameter, but approximately 3 ft. (91.4cm) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at gimbal housing water tube only. Do not clamp hose at engine end.



a - Water Inlet Hose
b - Hose Clamp
c - Gimbal Housing Water Tube

Figure 1. Water Inlet Hose (Typical)

2. Place a 6 quart (5.7 liter) or larger container near unclamped end of hose.

CAUTION: Do not run engine for more than 15 seconds with hose disconnected, in next step, as internal damage to engine and exhaust system may result.

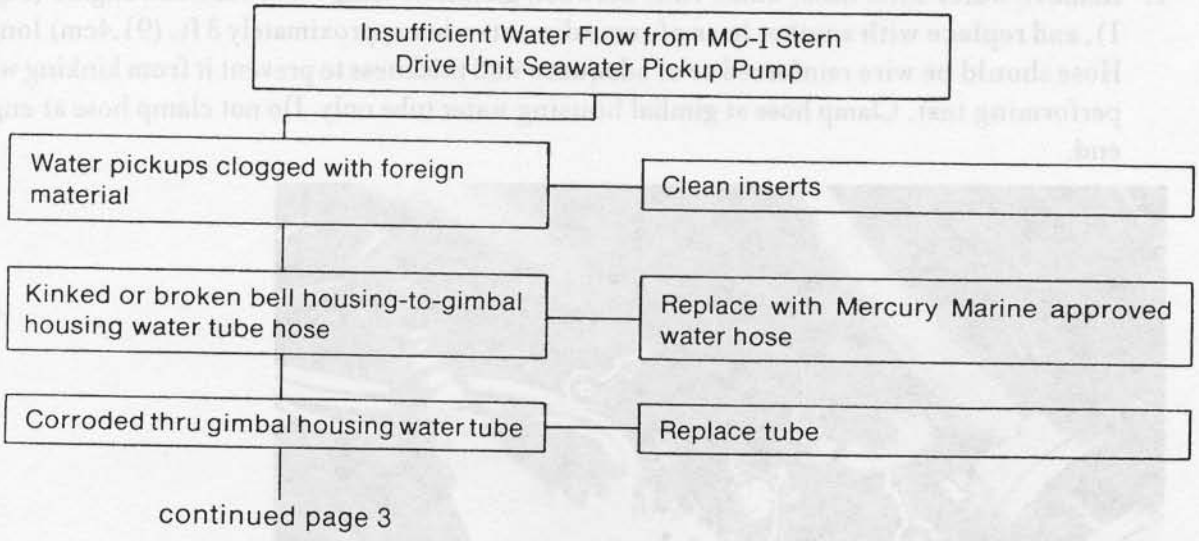
3. With the assistance of another person, start engine and adjust speed to exactly 1000 RPM, while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for EXACTLY 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
4. Measure quantity of water discharged into container and compare with specifications given in chart below.

MINIMUM PUMP OUTPUT FOR 15 SECOND PERIOD	
Drive Unit Gear Ratio	**Minimum Quantity**
1.98:1	3.0 Qts. (2.8 liters)
1.84:1	3.3 Qts. (3.1 liters)
1.65:1	3.6 Qts. (3.4 liters)
1.50:1	4.0 Qts. (3.8 liters)
1.32:1	4.5 Qts. (4.3 liters)

5. Repeat test 4 times to check repeatability of results.
6. If output is insufficient, refer to troubleshooting chart, following.

B. INSUFFICIENT WATER FLOW FROM MC-I STERN DRIVE UNIT SEAWATER PICKUP PUMP TROUBLESHOOTING CHART

The following troubleshooting chart should be of assistance when troubleshooting an overheating condition due to insufficient water flow from seawater pickup pump in drive unit. Possible causes are arranged by those which are easiest to check to those which are most difficult.



continued page 3

Water pickup inserts warped. (Engine will overheat while boat is underway only.)	Repair as necessary. (Refer to Service Bulletin 77-5.)
	NOTE: Pickup inserts must not protrude above gear housing surface or inserts will create an irregular or turbulent water flow over the water pickup holes. Consequently, this may cause loss of cooling water and subsequent engine overheating. This condition also can be identified by cavitation burn (pitting, erosion) on the gear housing in the area aft of the water pickup inserts.
Damaged gear housing or accessories improperly installed on boat bottom or transom (speedometer pickup, depth sounder transducer, etc.). Substantial amount of barnacles or other marine growth on gear housing or boat bottom. (Engine will overheat while underway only.)	Repair or clean as necessary.
	NOTE: An object or an irregularity on boat or gear housing in area close to water pickups could create turbulence in water flow going to water pickups. This could aerate the water flow and cause engine to overheat.
Stern drive installed too high on transom or drive unit trimmed too far out allowing air to be drawin into pump. (Engine will overheat while underway only.)	Contact boat company if stern drive is installed too high. Instruct operator on proper trimming technique if unit is trimmed out too far.
Bell housing-to-drive shaft housing "O" ring missing or damaged	Replace "O" ring.
Faulty seawater pickup pump	Repair pump as required.
Seawater pickup pump water tube corroded thru	Replace tube.
Drive shaft housing water pocket cover cracked	Replace cover.
Broken-off impeller blade or other obstruction in water passages (usually lodges in drive shaft housing water pocket cover or cross-drilled water passage).	Remove obstruction.
	NOTE: To check cross-drilled water passage in drive shaft housing, remove welch plug and pipe plug located under decal on starboard side of housing. Drive unit must be shifted into reverse to remove pipe plug.
Water passage in drive shaft housing improperly drilled	Check passage and redrill, if necessary, as explained following.

service bulletin

mercruiser
STERN DRIVES/INBOARD ENGINES

NUMBER: 82-9
DATE: 9/10/82

CIRCULATE TO:
SERVICE MANAGER
PARTS MANAGER
MECHANICS

A. NEW MERCRUISER I ALUMINUM PROPELLER LINE
B. NEW PROPELLER SHAFT LUBRICANT RECOMMENDATION

A. NEW MERCRUISER I ALUMINUM PROPELLER LINE

The current "MerCruiser I" aluminum propeller line will be superseded to the V-6 Outboard "Black Max" aluminum propeller line, shown below. (The MerCruiser I stainless steel propeller line was superseded earlier — refer to Service Bulletin 82-7). These propellers will perform approximately equal to their MerCruiser I predecessors. In some cases, their higher rake design (15° vs. 10°) will allow the drive unit to be trimmed "out" farther, thereby, holding the bow of the boat higher and providing improved boat performance.

BLACK MAX ALUMINUM PROPELLERS

Part Number	Diameter	Pitch
48-78112A4	16"	11"
48-78114A4	16"	13"
48-78116A4	15-1/4"	15"
48-78118A4	14-1/2"	17"
48-78120A4	14"	19"
48-78122A4	13-3/4"	21"
48-78124A4	13-1/2"	23"
48-78126A4	13-3/8"	25"

The propellers will be superseded, as shown below, when inventories of the current MerCruiser I propellers are depleted.

MC-I TO BLACK MAX PROPELLER SUPERSESSION

MC-I Propellers	Superseded by	Black Max Propellers
48-79582A4 27" Pitch	" "	None
48-79580A4 25" Pitch	" "	48-78126A4 25" Pitch
48-79578A4 23" Pitch	" "	48-78124A4 23" Pitch
48-79576A4 21" Pitch	" "	48-78122A4 21" Pitch
48-79574A4 19" Pitch	" "	48-78120A4 19" Pitch
48-79572A4 17" Pitch	" "	48-78118A4 17" Pitch
48-79570A4 15" Pitch	" "	48-78116A4 15" Pitch
48-79568A4 13" Pitch	" "	48-78114A4 13" Pitch

Our testing has shown that a reduction in engine speed of up to 150 RPM may be experienced when changing from a MerCruiser I to a Black Max propeller of the same pitch. Therefore, if engine RPM was in lower half of specified range with MerCruiser I propeller, a Black Max propeller 2" less in pitch than MerCruiser I propeller may be required to keep RPM within specified range (see example below).

EXAMPLE: An MCM 140 turned 4300 RPM at wide-open-throttle with a 21" pitch MerCruiser I propeller. Installation of a 21" pitch Black Max propeller would probably cause the engine to run at 4150 RPM at wide-open-throttle; therefore, a 19" pitch Black Max propeller would probably be required to maintain RPM within the specified range of 4200-4600 RPM.

Since the RPM difference between the MerCruiser I and the Black Max propellers vary with boat design, ALL boats should be retested after installing Black Max propellers to ensure that engine RPM falls within specified range. Normally, a 300-400 RPM change exists between propeller pitches within the Black Max propeller line.

When changing from a MerCruiser I to a Black Max propeller, a new forward thrust hub (77987) also is required. (Figure 1) Forward thrust hub (56292A2), used with MerCruiser I propellers, CANNOT be used with Black Max propellers. All other propeller attaching hardware remain the same.

CAUTION: If a MerCruiser I propeller is to be reinstalled in the future, forward thrust hub (56292A2) also MUST BE reinstalled. Forward thrust hub (77987), if used, will allow MerCruiser I propeller to contact gear housing and subsequent damage may result.

Long trim tab (34127A1) will interfere with the 15", 17", 19", 21", 23" and 25" pitch Black Max propellers. When using these propellers, short trim tab (31640A1) MUST BE used. (Figure 2) The short trim tab has been standard on all MerCruiser I Stern Drives since approximately the 1976 model year.

CAUTION: It is extremely important that the propeller attaching hardware is installed correctly and propeller nut is torqued to 55 lbs. ft. (75 N.m) minimum, or interference between propeller and trim tab may result. Attaching hardware is properly installed when at least two threads of propeller shaft are exposed thru propeller nut. Less than two threads being exposed could indicate that spline washer is not engaged with splines on propeller shaft. After installation, propeller should be rotated by hand (while pulling it rearward) to ensure that blades clear trim tab.

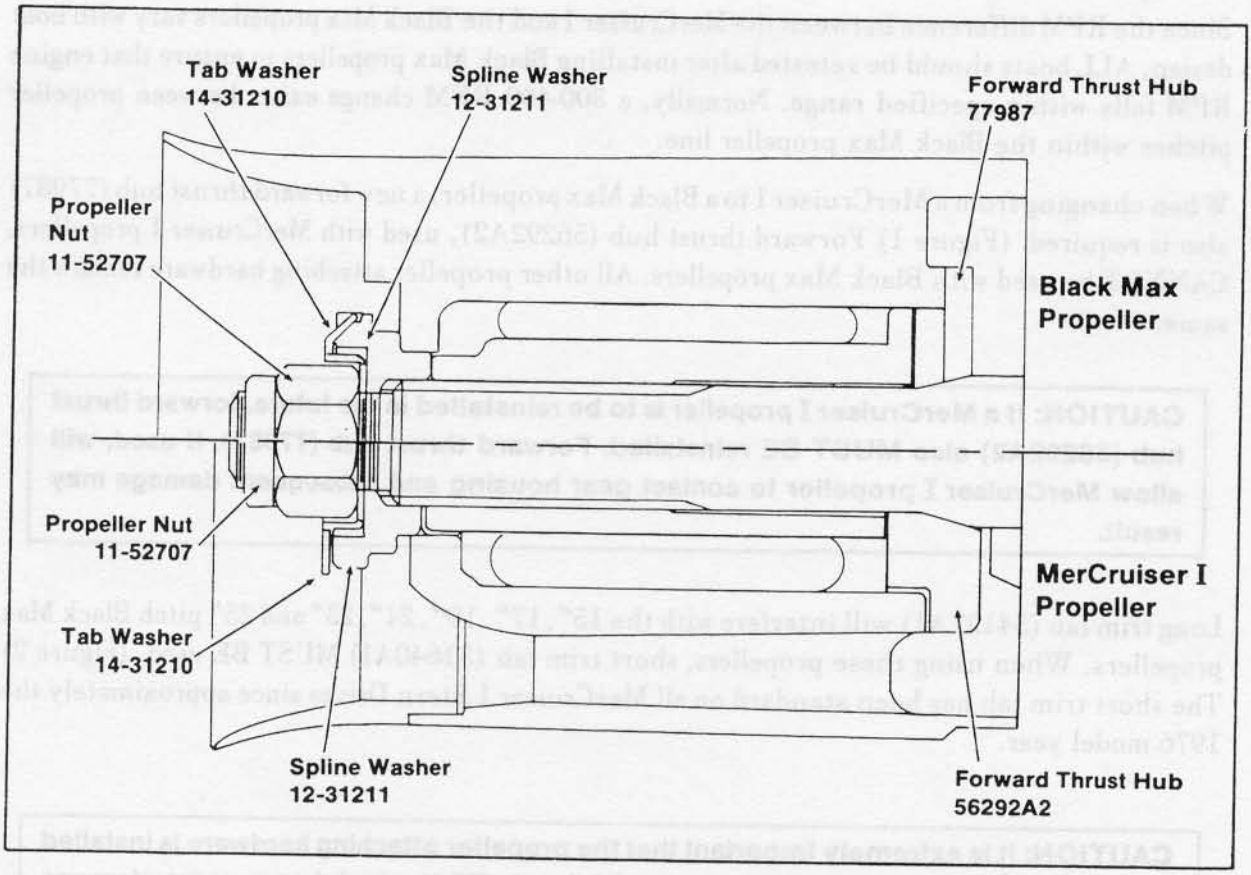


Figure 1. Black Max Propeller Attaching Hardware

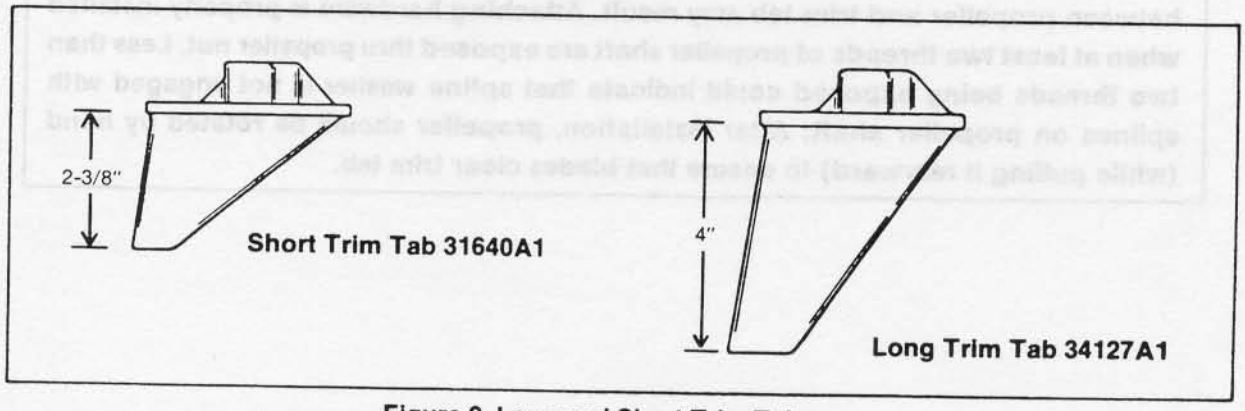


Figure 2. Long and Short Trim Tab

B. NEW PROPELLER SHAFT LUBRICANT RECOMMENDATION

We are adding two additional propeller shaft lubricants to our current recommendations. Any of the lubricants listed below can be used to lubricate propeller shaft. In the past, our only recommendation has been Perfect Seal.

Recommended Propeller Shaft Lubricants

- Quicksilver Special Lubricant 101 (92-79214)
- Quicksilver 2-4-C Multi-Lube (92-86154)
- Quicksilver Perfect Seal (92-34227)

Our testing has shown that Special Lubricant 101 will provide approximately twice the protection as Perfect Seal and, therefore, is recommended for use in areas where corrosion is a problem. The 2-4-C Multi-Lube also will provide greater protection than Perfect Seal, but is not quite as good as Special Lubricant 101.

Propeller shaft should be lubricated at intervals specified below or whenever propeller is removed for service. Failure to lubricate propeller shaft may result in difficult propeller removal in the future (due to corrosion between propeller hub and shaft).

Recommended Lubrication Intervals

- SALT, POLLUTED OR MINERAL LADEN WATER AREAS — Every 50 hours of operation or 60 days (whichever occurs first).
- FRESH WATER AREAS — Every 100 hours of operation or 120 days (whichever occurs first).

merCruiser STERN DRIVES & INBOARDS

service bulletin

NUMBER: 82-11

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

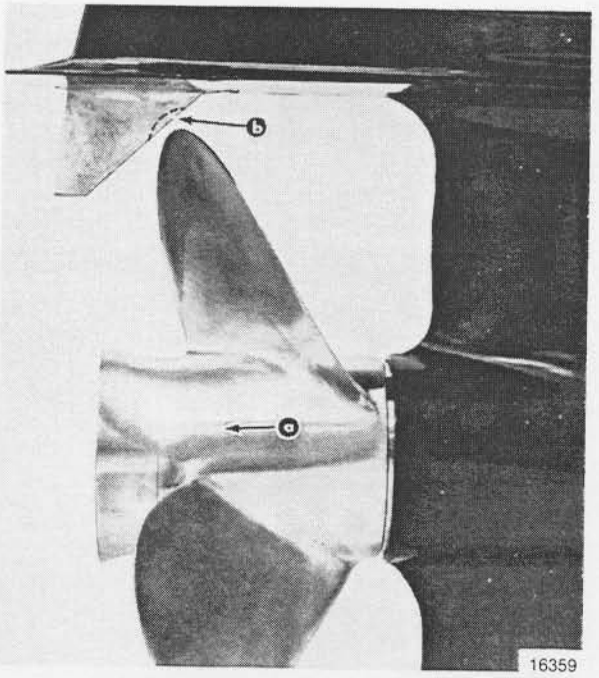
PROPELLER INTERFERENCE WITH TRIM TAB ON MERCRUISER I STERN DRIVES

Whenever installing a Black Max propeller on a MerCruiser I Stern Drive, be sure to check that sufficient clearance exists between propeller and trim tab. This is especially important when using a 17″ pitch Black Max stainless steel propeller (48-79794A4), as it has the least amount of clearance of all Black Max propellers.

To check for adequate clearance, pull propeller rearward while checking clearance between trim tab and each propeller blade. (Figure 1) A minimum of .100″ (3/32″ or 2.54mm) clearance should exist. If clearance is insufficient, check for the following:

- That short trim tab (31640A1) is being used. Use of long trim tab (34127A1) will cause interference.
- That forward thrust hub (77987) is being used. Use of forward thrust hub (56292A1 or A2) will cause propeller interference.
- That spline washer is engaged with splines on propeller shaft. Failure to mate splines will prevent propeller nut from drawing propeller into proper position on shaft.
- That propeller nut is torqued to 55 lbs. ft. (74.6 N.m) minimum.

If none of the preceding are the cause for interference, the trim tab MUST BE modified to provide sufficient clearance. Remove stock from trim tab with a file or a grinder, at location shown in Figure 1. Do not remove any more stock than absolutely necessary.



a - Pull Propeller Rearward
b - Remove Material from This Area Of Trim Tab If Clearance Is Less Than .100″ (3/32″ or 2.54mm)

Figure 1. Checking Propeller to Trim Tab Clearance

mercruiser STERN DRIVES & INBOARDS service bulletin

NUMBER: 83-30

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

A. Part Number and Pitch Stamped on Quicksilver Propellers
B. Propellers and Attaching Hardware for MerCruiser 80, 90, I, IA, IB, IC, IA-EZ, IB-EZ, IC-EZ, 120, 140 and 160
C. Propeller Forward Thrust Hub Usage on MerCruiser I Models

A. PART NUMBER AND PITCH STAMPED ON QUICKSILVER PROPELLERS

At your request, we will once again stamp the part number and pitch on the outer hub of Quicksilver propellers (40 horsepower and above). This will allow easier identification of propellers when installed. The stamping operation will be done as a running change and, therefore, you may receive propellers which are not stamped for a period of time.

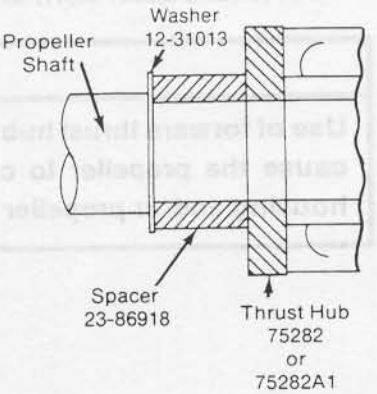
B. PROPELLERS AND ATTACHING HARDWARE FOR MERCRUISER 80, 90, I, IA, IB, IC, IA-EZ, IB-EZ, IC-EZ, 120, 140 and 160

The above models were originally equipped with propeller shafts that had a square thrust hub shoulder (as compared to the tapered thrust hub shoulder used on new models). When using the new style propellers (listed following) on these models, the attaching hardware shown MUST BE used.

MerCruiser 80, 90 and I

New Style Propellers

				Attaching Hardware
12-5/8"	25"	3	Stainless Steel	48-72758A4
12-1/2"	23"	3	Aluminum	48-77350A4
12-3/4"	23"	3	Stainless Steel	48-72760A4
12-3/4"	21"	3	Aluminum	48-77348A4
13"	21"	3	Stainless Steel	48-72500A4
13"	19"	3	Aluminum	48-77346A4
13-1/4"	19"	3	Stainless Steel	48-72762A4
13-1/4"	17"	3	Aluminum	48-77344A4
13-1/2"	17"	3	Stainless Steel	48-72764A4
13-3/4"	15"	3	Aluminum	48-77342A4
13-3/4"	15"	3	Stainless Steel	48-87444A4
14"	13"	3	Aluminum	48-77340A4
14"	11"	3	Aluminum	48-77338A4

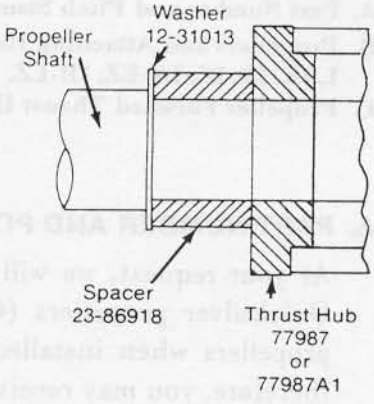


MerCruiser IA, IB, IC, IA-EZ, IB-EZ, IC-EZ, 120, 140 and 160

New Style Propellers

13-3/8"	25"	3	Stainless Steel	48-79796A4
13-3/8"	25"	3	Aluminum	48-78126A4
13-1/2"	23"	3	Stainless Steel	48-75724A4
13-1/2"	23"	3	Aluminum	48-78124A4
13-3/4"	21"	3	Stainless Steel	48-73982A4
13-3/4"	21"	3	Aluminum	48-78122A4
14"	19"	3	Stainless Steel	48-73980A4
14"	19"	3	Aluminum	48-78120A4
14-1/2"	17"	3	Stainless Steel	48-79794A4
14-1/2"	17"	3	Aluminum	48-78118A4
14-1/2"	15"	3	Stainless Steel	48-93272A4
15-1/4"	15"	3	Aluminum	48-78116A4
16"	13"	3	Aluminum	48-78114A4
16"	11"	3	Aluminum	48-78112A4

Attaching Hardware



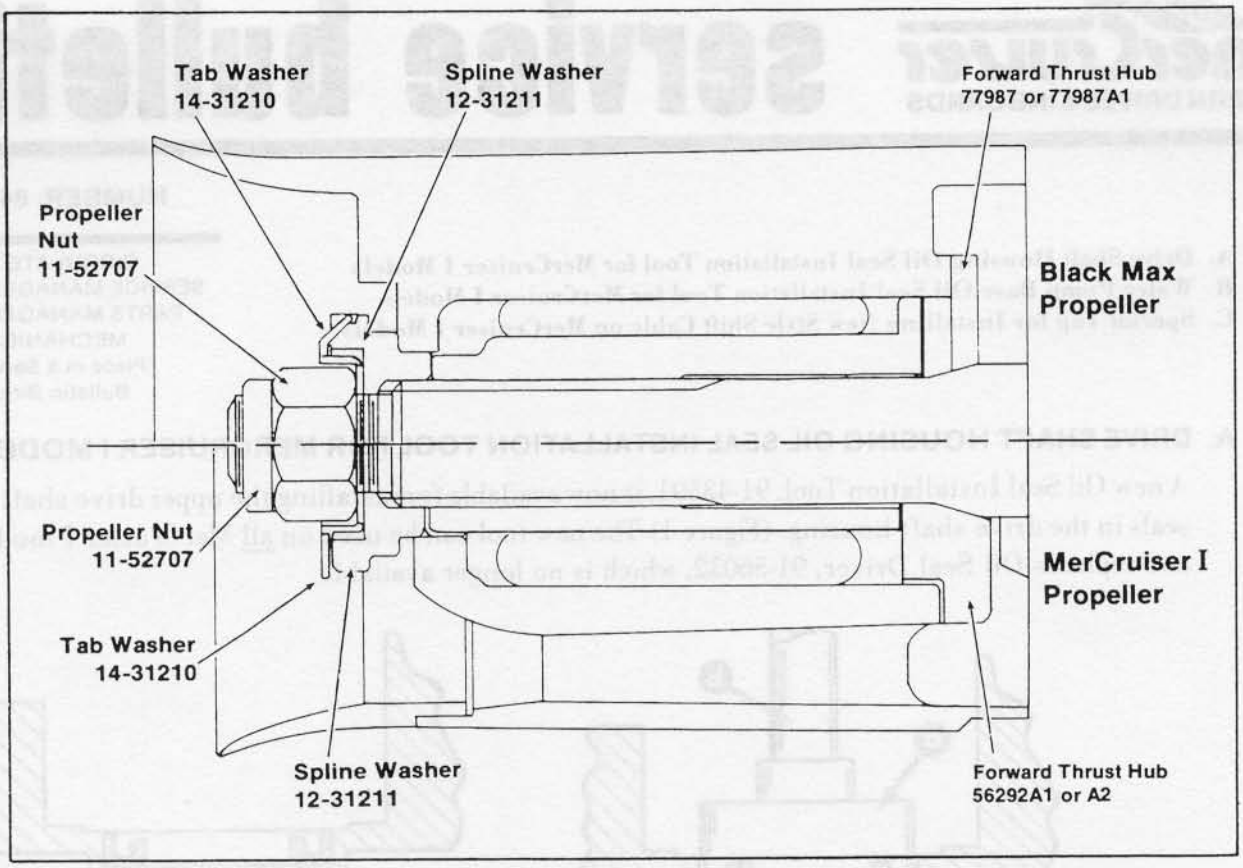
C. PROPELLER FORWARD THRUST HUB USAGE ON MERCRUISER I MODELS

Just as a reminder, the forward thrust hub must be selected to correspond with the propeller being used on MerCruiser I models (refer to chart, following).

- When using the older MerCruiser I propellers, forward thrust hub (56292A1 or A2) must be used. This hub is made of bronze and is fitted with a stainless steel washer. The number "56292" is cast into one of the cavities.
- When using the new Black Max propellers, forward thrust hub (77987 or 77987A1) must be used. This hub is made of aluminum and has a casting number of "77987". All MerCruiser 120R-thru-260R stern drive units are originally equipped with this hub.

⚠CAUTION

Use of forward thrust hub (77987 or 77987A1) with an older MerCruiser I propeller will cause the propeller to contact the gear housing and subsequent damage to the housing and/or propeller may result.



BLACK MAX PROPELLERS

48-78126A4	48-78112A4
48-78124A4	48-79796A4
48-78122A4	48-75724A4
48-78120A4	48-73982A4
48-78118A4	48-73980A4
48-78116A4	48-79794A4
48-78114A4	48-93272A4

MERCRUISER I PROPELLERS

48-79580A4	48-88446A4
48-79578A4	48-88444A4
48-79576A4	48-88442A4
48-79574A4	48-88440A4
48-79572A4	48-88438A4
48-79570A4	(And All Older
48-79568A4	MC-I Propellers)

mercruiser STERN DRIVES & INBOARDS

service bulletin

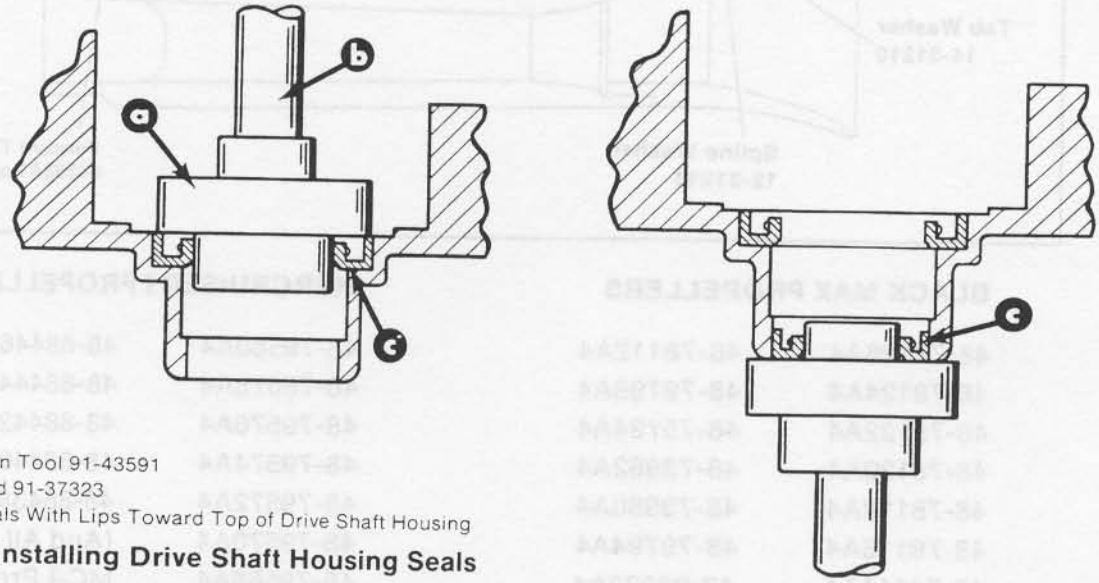
NUMBER: 84-16

A. Drive Shaft Housing Oil Seal Installation Tool for MerCruiser I Models
B. Water Pump Base Oil Seal Installation Tool for MerCruiser I Models
C. Special Tap for Installing New Style Shift Cable on MerCruiser I Models

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

A. DRIVE SHAFT HOUSING OIL SEAL INSTALLATION TOOL FOR MERCRUISER I MODELS

A new Oil Seal Installation Tool, 91-43591, is now available for installing the upper drive shaft oil seals in the drive shaft housing. (Figure 1) The new tool can be used on all MerCruiser I models and replaces Oil Seal Driver, 91-56032, which is no longer available.

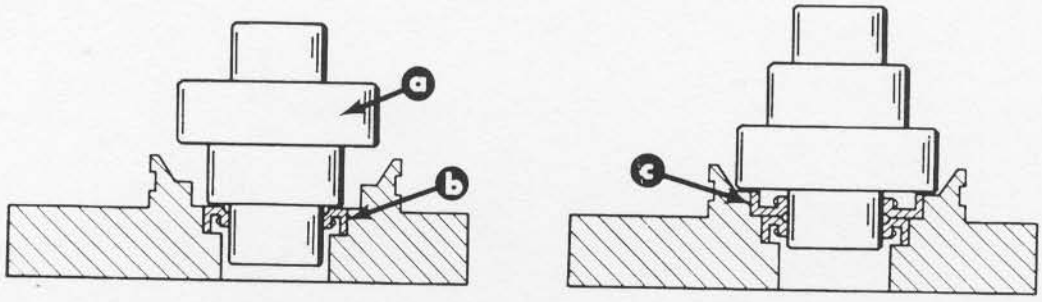


a - Installation Tool 91-43591
b - Driver Rod 91-37323
c - Install Seals With Lips Toward Top of Drive Shaft Housing

Figure 1. Installing Drive Shaft Housing Seals

B. WATER PUMP BASE OIL SEAL INSTALLATION TOOL FOR MERCRUISER I MODELS

An Oil Seal Installation Tool, 91-44110 is now available for installing oil seals in the water pump base. (Figure 2) This tool will work on all MerCruiser I models and all 75 HP and above Mercury/Mariner models.



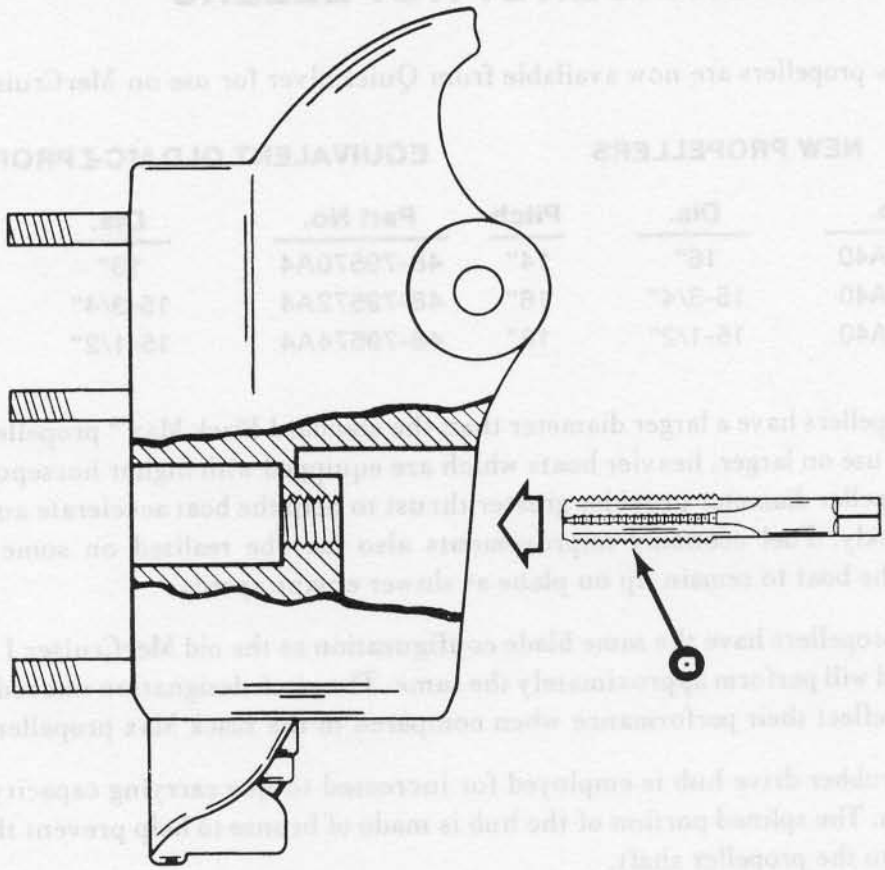
a - Installation Tool 91-44110
b - Install Upper Seal With Lip Toward Water Pump
c - Install Lower Seal With Lip Toward Gear Housing

Figure 2. Installing Oil Seals In Water Pump Base

C. SPECIAL TAP FOR INSTALLING NEW STYLE SHIFT CABLE ON MERCRUISER I

MerCruiser 120R-thru-260R drive unit shift cable, 41951A1 (which attaches to bell housing from aft end) can be used on older MerCruiser I models. To do this, threaded hole in bell housing must be tapped all-the-way thru, using a ¼-18 NPSF tap. (Figure 3) This special straight thread tap may be difficult to obtain in some areas, therefore, Mercury Marine will now offer it under part number 91-95639. The following important information must be observed when performing tapping operation:

- Tapping must be done from the front (bellows) end of bell housing to prevent cross-threading.
- Never use a tapered thread tap as improper positioning of shift cable may result.



a - Tap 91-95639

Figure 3. Tapping Threaded Hole In Bell Housing

mercruiser STERN DRIVES & INBOARDS service bulletin

NUMBER: 84-28

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

LARGE DIAMETER MERCRUISER I PROPELLERS

Three new propellers are now available from Quicksilver for use on MerCruiser I models.

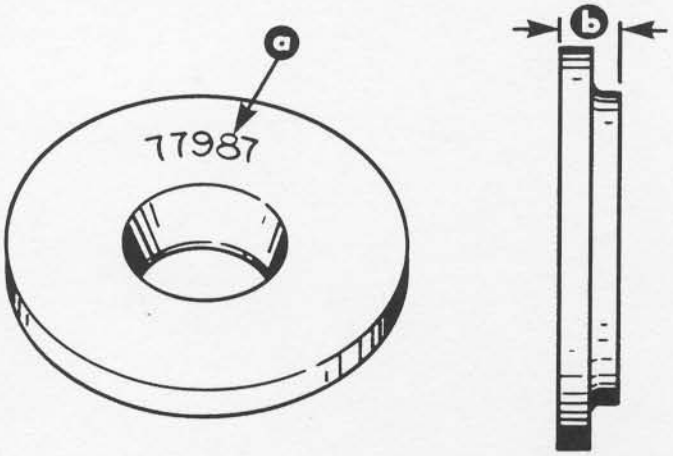
NEW PROPELLERS			EQUIVALENT OLD MC-I PROPELLERS		
Part No.	Dia.	Pitch	Part No.	Dia.	Pitch
48-11320A40	16"	14"	48-79570A4	16"	15"
48-11322A40	15-3/4"	16"	48-79572A4	15-3/4"	17"
48-11324A40	15-1/2"	18"	48-79574A4	15-1/2"	19"

These propellers have a larger diameter than the standard Black Max™ propellers and are ideally suited for use on larger, heavier boats which are equipped with higher horsepower engines. The larger propeller diameter provides greater thrust to help the boat accelerate and get up on plane more quickly. Fuel economy improvements also may be realized on some applications, by allowing the boat to remain up on plane at slower engine speeds.

The new propellers have the same blade configuration as the old MerCruiser I propellers (listed above) and will perform approximately the same. The pitch designation was reduced by one inch to better reflect their performance when compared to the Black Max propeller line.

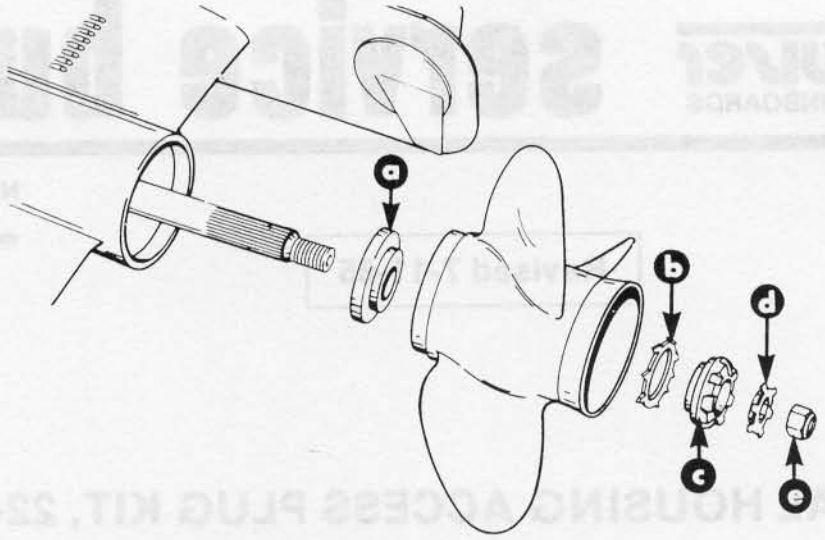
A square rubber drive hub is employed for increased torque carrying capacity and good shock absorption. The splined portion of the hub is made of bronze to help prevent the propeller from seizing onto the propeller shaft.

The new propellers require the same forward thrust hub, 77987 or 77987A1 (Figure 1) as the Black Max propellers. All other propeller attaching parts are also the same. (Figure 2) Either the standard trim tab, 31640A1 or long tab, 34127A1 can be used when using these propellers.



a - Part Number Location
b - 7/16" (11mm)

Figure 1. Forward Thrust Hub 77987 & 77987A1



a - Forward Thrust Hub 77987 or 77987A1
b - Continuity Washer 13-42351 (Models So Equipped)
c - Spline Washer 12-31211A2
d - Tab Washer 14-31210
e - Nut 11-52707A1

Figure 2. Propeller Attaching Parts

mercruiser STERN DRIVES & INBOARDS **service bulletin**

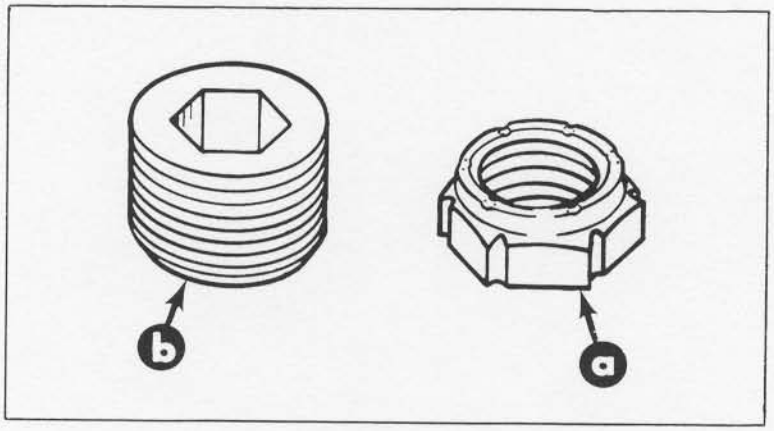
NUMBER: 85-2

Revised 7-11-85

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

GIMBAL HOUSING ACCESS PLUG KIT, 22-88847A1

Two access holes must be drilled in the gimbal housing to allow the gimbal ring, swivel shaft and steering lever to be removed (without removing the gimbal housing) on MerCruiser I, TR and TRS models. A gimbal housing access plug kit (22-88847A1) is now available for this purpose. Kit contains two plugs for sealing the access holes and a special swivel shaft nut to allow installation with a punch. (Figure 1) A template also is included in the kit to locate the access holes. (Figure 2) Refer to the appropriate service manual for gimbal ring, swivel shaft and steering lever removal and installation procedure.



a - Swivel Shaft Nut, 11-88462
b - Plastic Plugs, 22-88847 (2)

Figure 1. Access Plug Kit, 22-88847A1

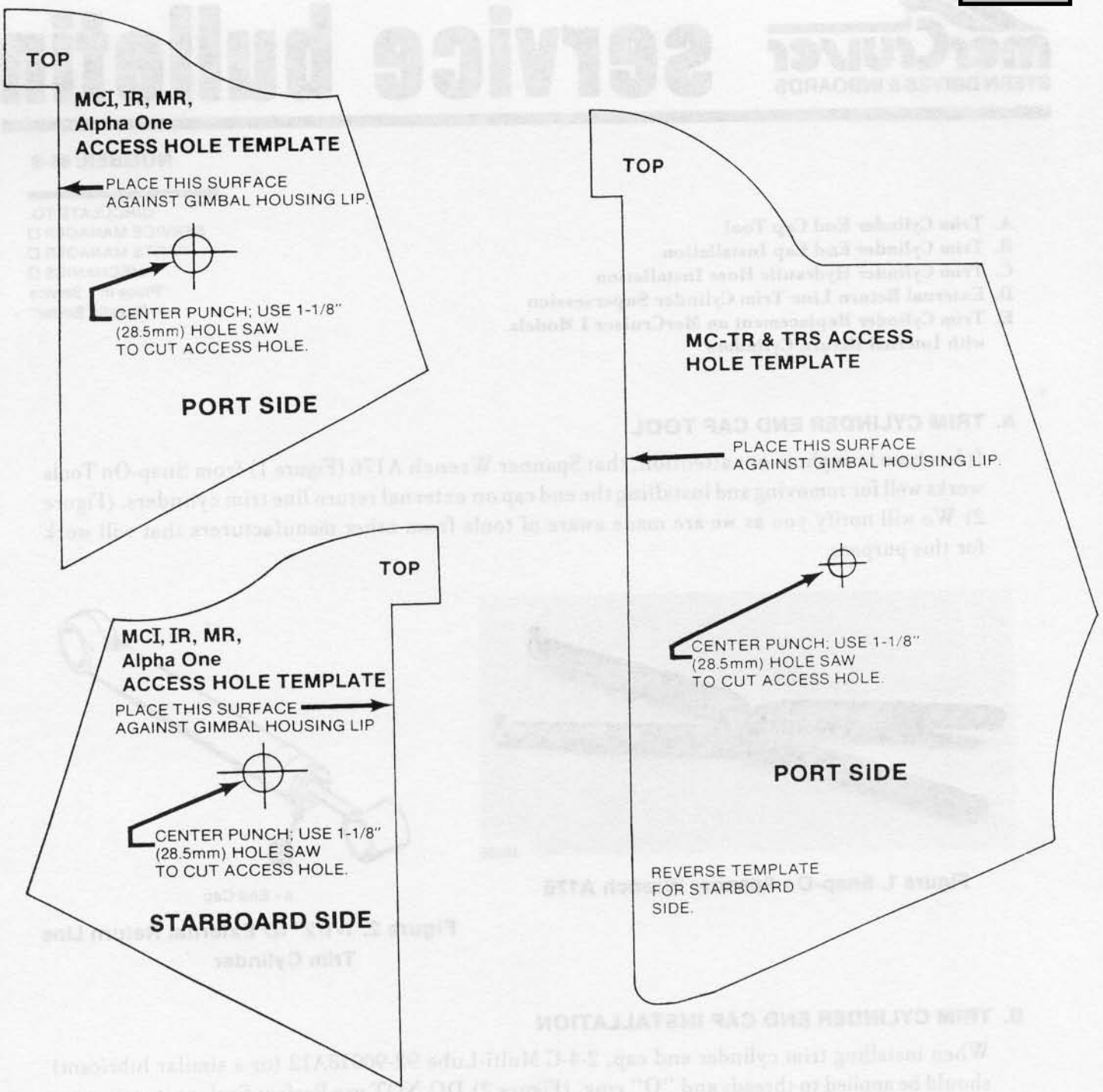


Figure 2. Access Hole Locating Template

merCruiser
STERN DRIVES & INBOARDS

service bulletin

NUMBER: 85-9

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

A. Trim Cylinder End Cap Tool
B. Trim Cylinder End Cap Installation
C. Trim Cylinder Hydraulic Hose Installation
D. External Return Line Trim Cylinder Supersession
E. Trim Cylinder Replacement on MerCruiser I Models with Internal Return Cylinders

A. TRIM CYLINDER END CAP TOOL

It has been brought to our attention, that Spanner Wrench A176 (Figure 1) from Snap-On Tools works well for removing and installing the end cap on external return line trim cylinders. (Figure 2) We will notify you as we are made aware of tools from other manufacturers that will work for this purpose.

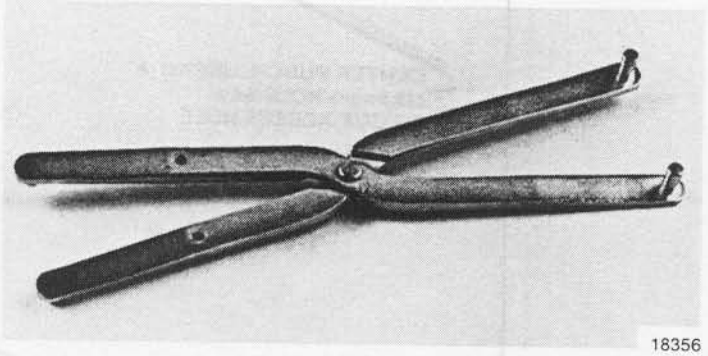
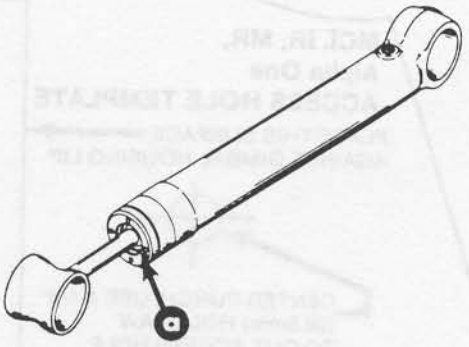


Figure 1. Snap-On Spanner Wrench A176



a - End Cap

Figure 2. 1-1/2" ID External Return Line Trim Cylinder

B. TRIM CYLINDER END CAP INSTALLATION

When installing trim cylinder end cap, 2-4-C Multi-Lube 92-90018A12 (or a similar lubricant) should be applied to threads and "O" ring. (Figure 2) DO NOT use Perfect Seal, as it may cause poor-electrical continuity between end cap and outer tube with subsequent corrosion of end cap and piston rod resulting.

C. TRIM CYLINDER HYDRAULIC HOSE INSTALLATION

Occasionally, we receive reports of new trim cylinder hydraulic hoses failing shortly after installation. In investigating these cases, we have found that many of the failures are due to the hose being twisted and kinked during installation. When connecting the hoses to the gimbal housing hydraulic connector, a pliers should be used to prevent the hose from twisting. (Figure 3)

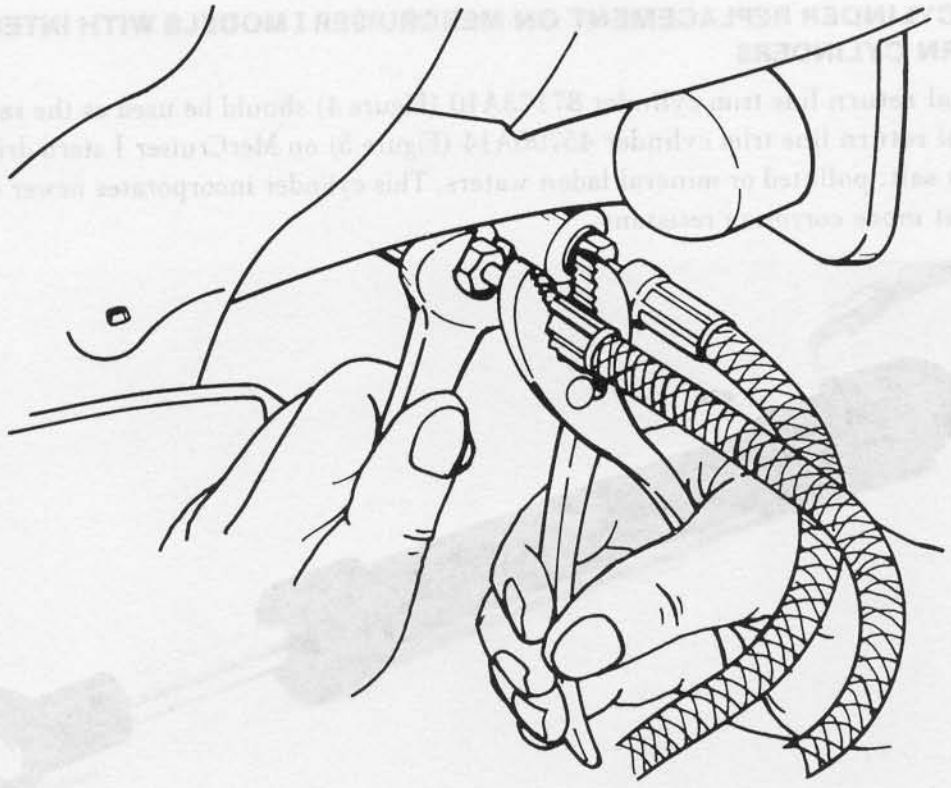


Figure 3. Trim Cylinder Hydraulic Hose Installation

D. EXTERNAL RETURN LINE TRIM CYLINDER SUPERSESSION

External return line trim cylinder, 87173A5 (used on older MC-I Models) has been superseded to 87173A10. The new cylinder differs only from the old one in that it has 2 return ports instead of one. This is necessary to enable cylinder to be used with stern drive units having the wide splash plate (refer to Service Bulletin 84-12). Hydraulic hoses must be connected to cylinders as shown in Figure 4.

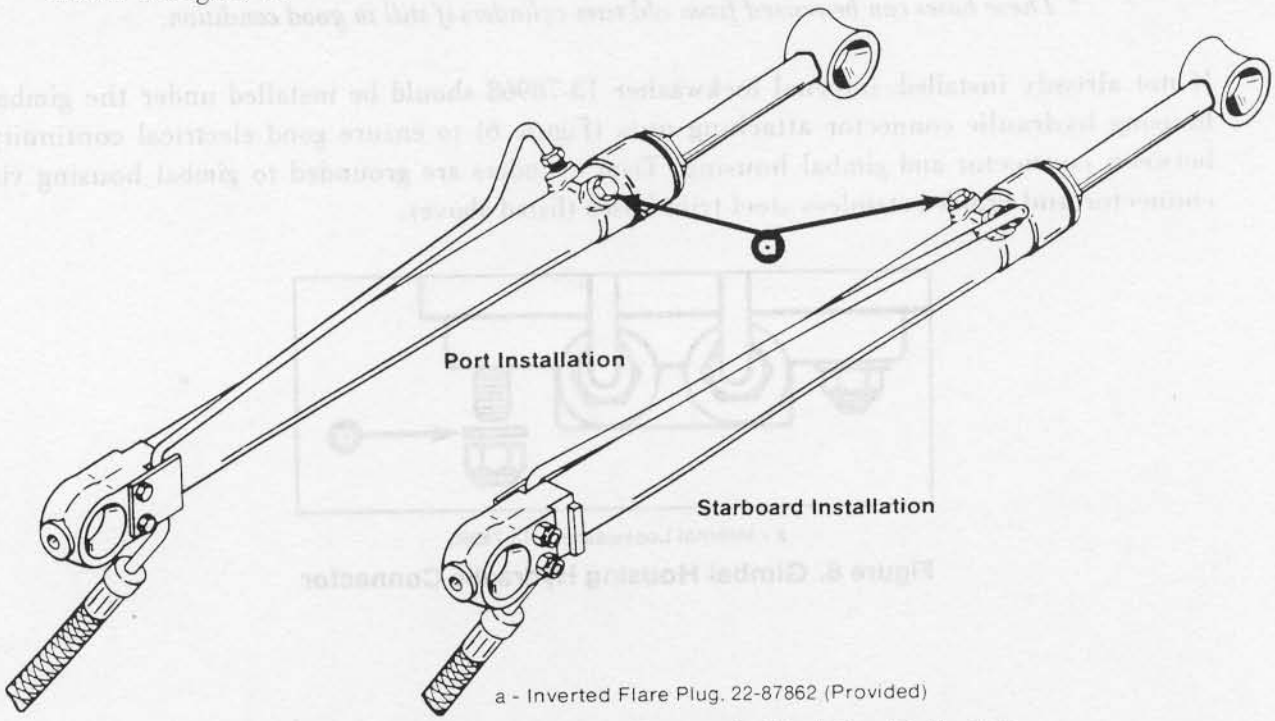


Figure 4. Hydraulic Hoses Connected to Trim Cylinders

E. TRIM CYLINDER REPLACEMENT ON MERCRUISER I MODELS WITH INTERNAL RETURN CYLINDERS

External return line trim cylinder 87173A10 (Figure 4) should be used as the replacement for internal return line trim cylinder 45706A14 (Figure 5) on MerCruiser I stern drives which are used in salt, polluted or mineral laden waters. This cylinder incorporates newer designs which makes it more corrosion resistant.

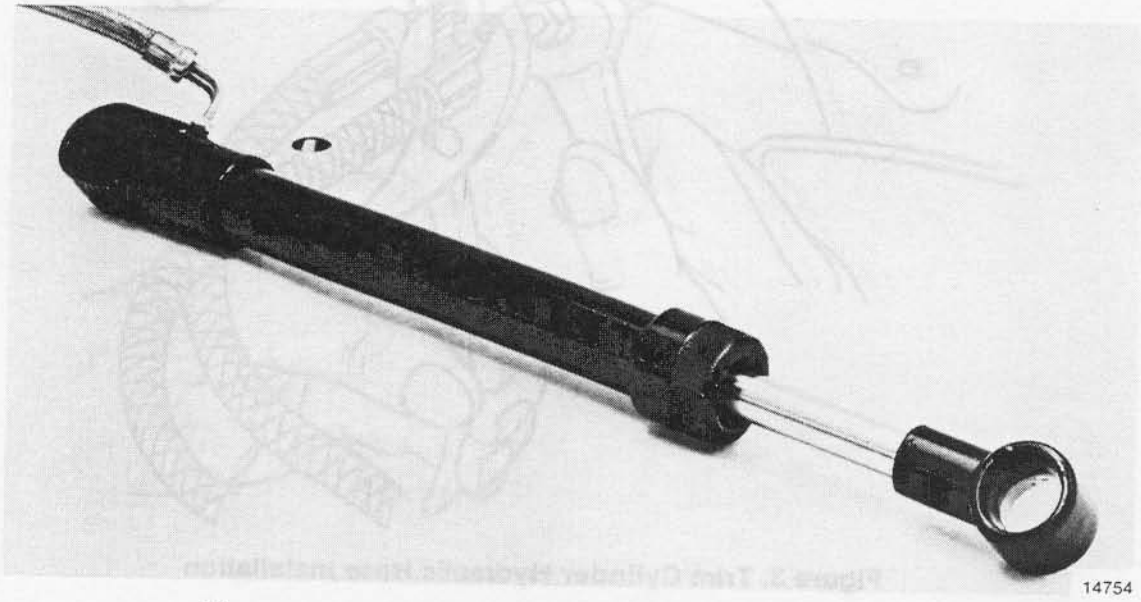


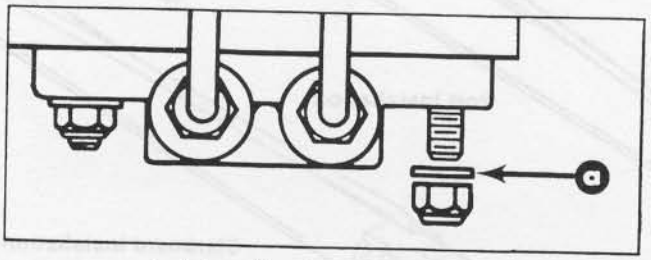
Figure 5. Internal Return Line Trim Cylinder 45706A14

When installing these cylinders, the hydraulic hoses listed below are required.

- *32-86036 Hose (2 Req'd, 1 Port Cylinder, 1 Starboard Cylinder)
- 32-87234 Hose (Port Cylinder)
- 32-87235 Hose (Starboard Cylinder)

* *These hoses can be reused from old trim cylinders if still in good condition.*

If not already installed, internal lockwasher 13-78968 should be installed under the gimbal housing hydraulic connector attaching nuts (Figure 6) to ensure good electrical continuity between connector and gimbal housing. Trim cylinders are grounded to gimbal housing via connector and braided stainless steel trim hoses (listed above).

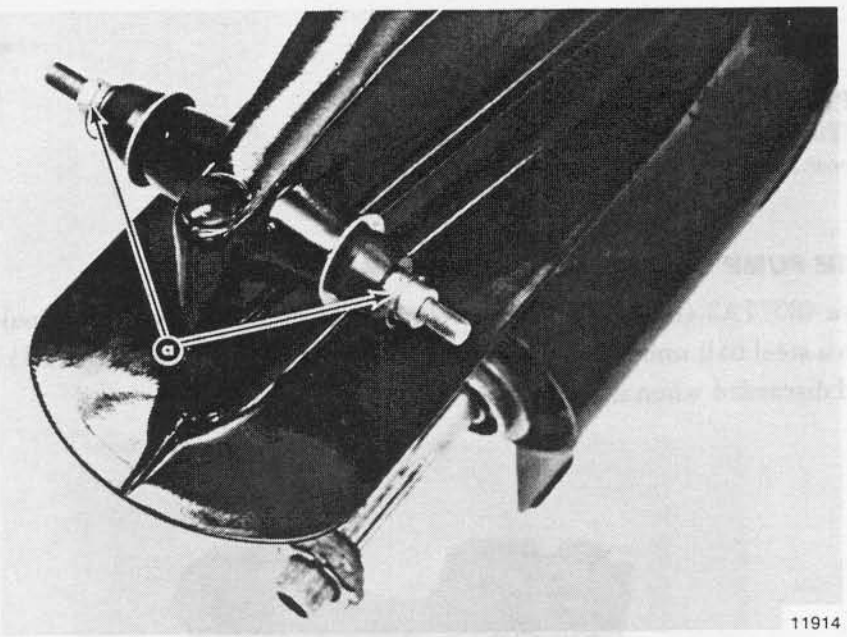


a - Internal Lockwashers, 13-78968

Figure 6. Gimbal Housing Hydraulic Connector

When installing trim cylinders, be sure to use a spiral grounding spring, 24-46312 at each end. (Figure 7)

Trim cylinders must be grounded as outlined preceding for sacrificial zinc anodes and MerCathode System (if so equipped) to protect them.



a - Spiral Grounding Springs, 24-46312

Figure 7. Trim Cylinder Spiral Grounding Springs

mercruiser STERN DRIVES & INBOARDS service bulletin

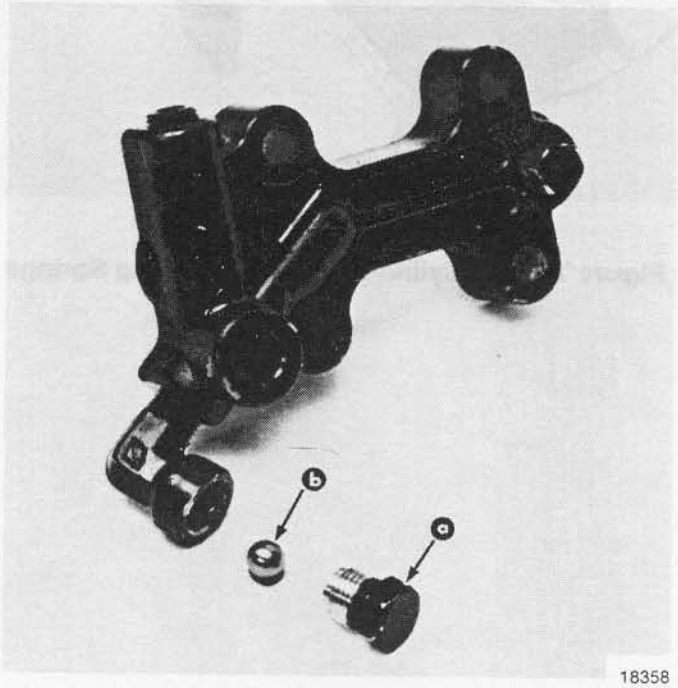
NUMBER: 85-10

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

A. Power Trim Pump Control Valve 48077A3
B. Power Trim/Tilt Pump 45060A7
C. Prestolite Power Trim Pump Valve Body Repair

A. POWER TRIM PUMP CONTROL VALVE 48077A3

Control valve 48077A3 (used on Prestolite Power Trim pumps with external control valve) is shipped with a steel ball under the shipping plug in the down port. (Figure 1) This ball must be removed and discarded when installing valve.



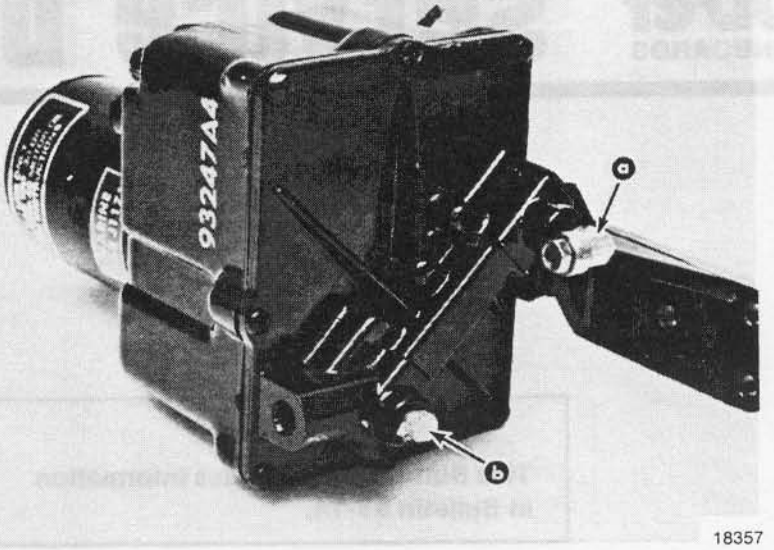
a - Shipping Plug
b - Steel Ball

Figure 1. Control Valve 48077A3

B. POWER TRIM/TILT PUMP 45060A7

Power Trim Pump, 45060A7 has been made no longer available. This pump was used on both Mercury Outboard and MerCruiser Products. For MerCruiser use, now order pump assembly 93247A4; for outboard use, order pump assembly, 92975A6. **Pump must be ordered under the new part number, as old number does not supersede up.**

When pump assembly, 93247A4 is used on MerCruiser models with power tilt, elbow fitting must be removed and a ⅛" NPT pipe plug 22-32802 must be installed in down port. (Figure 2)



a - Remove Elbow Fitting and Install 1/8" NPT Pipe Plug 22-32802
b - Connect Hydraulic Hose To This Port

Figure 2. Pipe Plug Installed In Down Port

C. PRESTOLITE POWER TRIM PUMP VALVE BODY REPAIR

Requests have been received from dealers and customers inquiring about "rebuilding" of the Power Trim pump valve bodies by an authorized Prestolite rebuilder.

Prestolite has advised that the valve body is not economically repairable and they do not offer replacement parts. They do, however, advise that the electric motor can be repaired by their authorized repair station.

merCruiser STERN DRIVES & INBOARDS

service bulletin

NUMBER: 85-20

CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

NOTICE
This Bulletin Supercedes Information in Bulletin 83-14.

Subject: MerCruiser I Drive Shaft Housing Gear Identification

Use the following chart when servicing MerCruiser I drive shaft housings to determine which gear ratio and gear set is being used and the shimming tool requirements.

- It should be kept in mind, that more than one gear set has been used on many of the models.
- DO NOT rely on the gear ratio stamped into the housing, as a different gear ratio may have been installed without the housing being remarked.

DRIVE SHAFT HOUSING GEAR SPECIFICATIONS

MerCruiser Model	D.S.H. Gear Teeth No. (Drive/ Driven)	D.S.H. Gear Set Part No.	Overall Drive Gear Ratio	Drive Gear Shimming Tool No. (and Position)	Driven Gear Shimming Tool No. (and Position)
60-80	11/11	43-38122A2 or 43-55427A1	60-1.64:1 80-2:1	91-36763	91-38764
90	11/11	43-55427A1	2:1	91-36763	91-38764
I	21/28	43-33538A1	2:1	91-33487 or 91-36385 ("MC-I")	91-33488
IA (EZ and NON-EZ)	21/23	43-36342A1	1.84:1	91-36385 ("A-B")	91-36384 ("A")
	20/24	43-45615A2 (NOTE 1)	1.98:1	91-45878 ("X", "120" or "B") or 91-60523 ("X")	91-45877 ("120" or "B") or 91-60526 ("Y")
IB (EZ and NON-EZ)	20/24	43-36219A1	2.01:1	91-36385 ("A-B")	91-36384 ("B")
		43-45615A2 (NOTE 1)	1.98:1	91-45878 ("X", "120" or "B") or 91-60523 ("X")	91-45877 ("120" or "B") or 91-60526 ("Y")
IC (EZ and NON-EZ)	24/24	43-35994A2	1.68:1	91-36385 ("C")	91-36384 ("C")
		43-45569A2 (NOTE 1)	1.68:1	91-45878 ("Y", "160" or "C") or 91-60523 ("Y")	91-45877 ("160" or "C") or 91-60526 ("X")
120/140 (S/N 2791956 and Below) NOTE 2	20/24	43-45615A2	1.98:1	91-45878 ("X", "120" or "B") or 91-60523 ("X")	91-45877 ("120" or "B") or 91-60526 ("Y")
120/120R/ 120MR/140/ 140R/140MR (S/N 2791957 and Above) NOTE 2	20/24	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")
160	24/24	43-45569A2	1.68:1	91-45878 ("Y", "160" or "C") or 91-60523 ("Y")	91-45877 ("160" or "C") or 91-60526 ("X")
165	24/24 Standard	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
	20/24 High Elevation (NOTE 3)	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")

470/470R/ 170MR/485/ 488R/190MR/ 185R/185MR	17/19 Standard	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
	24/24 Optional	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	20/24 High Elevation (NOTE 3)	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")
888/898/ 898R/225-S/ 228/228R/ 230MR	22/20 Standard	43-59832A2	1.50:1	91-60523 ("Z")	91-60526 ("Z")
	24/24 Standard & High Elevation (Note 3 & 4)	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
200MR/ 205MR	24/24 Standard	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	22/20 Optional	43-59832A2	1.50:1	91-60523 ("Z")	91-60526 ("Z")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
	20/24 High Elevation (NOTE 3)	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")
233/250/260/ 260R/260MR/ 300MR	20/16 (NOTE 5)	43-66773A2	1.32:1	91-60523 ("Z")	91-60526 ("Z")
	22/20 (NOTE 5)	43-59832A2	1.50:1	91-60523 ("Z")	91-60526 ("Z")
	24/24 High Elevation (NOTE 3)	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")

NOTE 1: Drive units with this gear set will not have shock absorbers.

NOTE 2: If serial number is not available, use the following means to categorize 120/140 drive unit:

- *On units with Serial Number 2791956 and below, driven gear is attached to upper drive shaft with a nut*
- *On units with Serial Number 2791957 and above, driven gear has a press fit on upper drive shaft (no nut)*

NOTE 3: For high elevation gear ratio recommendations, contact your Mercury Marine Regional Serivce Center.

NOTE 4: Newer production MerCruiser 898R models are equipped with this ratio as standard.

NOTE 5: MerCruiser 233, 250, 260 and 260R models could be equipped with either the 1.50:1 or 1.32:1 ratio.

DRIVE SHAFT HOUSING GEAR SPECIFICATIONS

MerCruiser Model	D.S.H. Gear Teeth No. (Drive/ Driven)	D.S.H. Gear Set Part No.	Overall Drive Gear Ratio	Drive Gear Shimming Tool No. (and Position)	Driven Gear Shimming Tool No. (and Position)
60-80	11/11	43-38122A2 or 43-55427A1	60-1.64:1 80-2:1	91-36763	91-38764
90	11/11	43-55427A1	2:1	91-36763	91-38764
I	21/28	43-33538A1	2:1	91-33487 or 91-36385 ("MC-I")	91-33488
IA (EZ and NON-EZ)	21/23	43-36342A1	1.84:1	91-36385 ("A-B")	91-36384 ("A")
	20/24	43-45615A2 (NOTE 1)	1.98:1	91-45878 ("X", "120" or "B") or 91-60523 ("X")	91-45877 ("120" or "B") or 91-60526 ("Y")
IB (EZ and NON-EZ)	20/24	43-36219A1	2.01:1	91-36385 ("A-B")	91-36384 ("B")
		43-45615A2 (NOTE 1)	1.98:1	91-45878 ("X", "120" or "B") or 91-60523 ("X")	91-45877 ("120" or "B") or 91-60526 ("Y")
IC (EZ and NON-EZ)	24/24	43-35994A2	1.68:1	91-36385 ("C")	91-36384 ("C")
		43-45569A2 (NOTE 1)	1.68:1	91-45878 ("Y", "160" or "C") or 91-60523 ("Y")	91-45877 ("160" or "C") or 91-60526 ("X")
120/140 (S/N 2791956 and Below) NOTE 2	20/24	43-45615A2	1.98:1	91-45878 ("X", "120" or "B") or 91-60523 ("X")	91-45877 ("120" or "B") or 91-60526 ("Y")
120/120R/ 120MR/140/ 140R/140MR (S/N 2791957 and Above) NOTE 2	20/24	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")
160	24/24	43-45569A2	1.68:1	91-45878 ("Y", "160" or "C") or 91-60523 ("Y")	91-45877 ("160" or "C") or 91-60526 ("X")
165	24/24 Standard	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
	20/24 High Elevation (NOTE 3)	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")

470/470R/ 170MR/485/ 488R/190MR/ 185R/185MR	17/19 Standard	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
	24/24 Optional	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	20/24 High Elevation (NOTE 3)	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")
888/898/ 898R/225-S/ 228/228R/ 230MR	22/20 Standard	43-59832A2	1.50:1	91-60523 ("Z")	91-60526 ("Z")
	24/24 Standard & High Elevation (Note 3 & 4)	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
200MR/ 205MR	24/24 Standard	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	22/20 Optional	43-59832A2	1.50:1	91-60523 ("Z")	91-60526 ("Z")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")
	20/24 High Elevation (NOTE 3)	43-55766A2	1.98:1	91-60523 ("Y")	91-60526 ("Y")
233/250/260/ 260R/260MR/ 300MR	20/16 (NOTE 5)	43-66773A2	1.32:1	91-60523 ("Z")	91-60526 ("Z")
	22/20 (NOTE 5)	43-59832A2	1.50:1	91-60523 ("Z")	91-60526 ("Z")
	24/24 High Elevation (NOTE 3)	43-55765A2	1.65:1	91-60523 ("Y")	91-60526 ("X")
	17/19 High Elevation (NOTE 3)	43-75324A2	1.84:1	91-60523 ("Y")	91-60526 ("Y")

NOTE 1: Drive units with this gear set will not have shock absorbers.

NOTE 2: If serial number is not available, use the following means to categorize 120/140 drive unit:

- *On units with Serial Number 2791956 and below, driven gear is attached to upper drive shaft with a nut*
- *On units with Serial Number 2791957 and above, driven gear has a press fit on upper drive shaft (no nut)*

NOTE 3: For high elevation gear ratio recommendations, contact your Mercury Marine Regional Serivce Center.

NOTE 4: Newer production MerCruiser 898R models are equipped with this ratio as standard.

NOTE 5: MerCruiser 233, 250, 260 and 260R models could be equipped with either the 1.50:1 or 1.32:1 ratio.

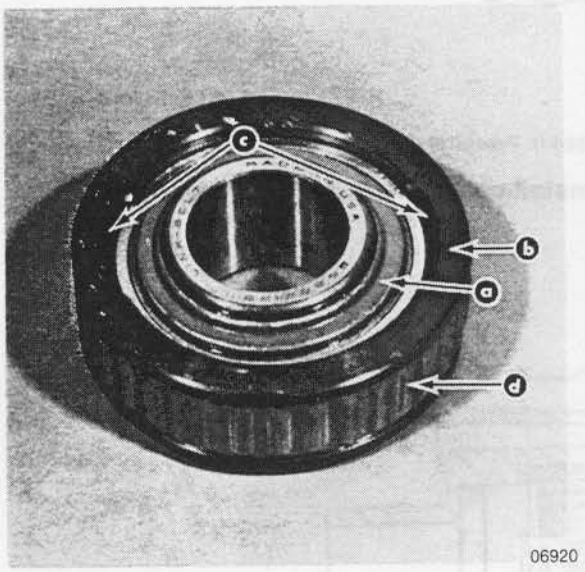
mercruiser STERN DRIVES & INBOARDS service bulletin

NUMBER: 85-26

GIMBAL BEARING SERVICING ON MERCRUISER I MODELS

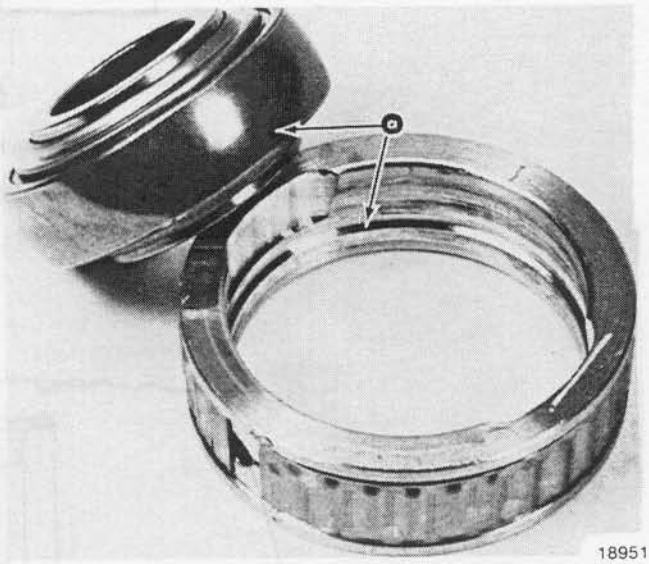
CIRCULATE TO:
SERVICE MANAGER ☐
PARTS MANAGER ☐
MECHANICS ☐
"Place in a Service Bulletin Binder"

We frequently hear reports where someone has replaced a gimbal bearing without replacing the cartridge. (Figure 1) **This should not be done under any circumstances.** The bearing is selectively fitted to the cartridge during manufacturing and must remain together as a matched set. Failure to do this, could result in a loose fit between bearing and cartridge and cause a noise similar to U-joint knocking. Secondly, bearing may be damaged from lack of lubrication, if bearing is installed backward. (Figure 2)



a - Bearing
b - Cartridge
c - Bearing Removal and Installation Slots
d - Tolerance Ring

Figure 1. Gimbal Bearing Assembly



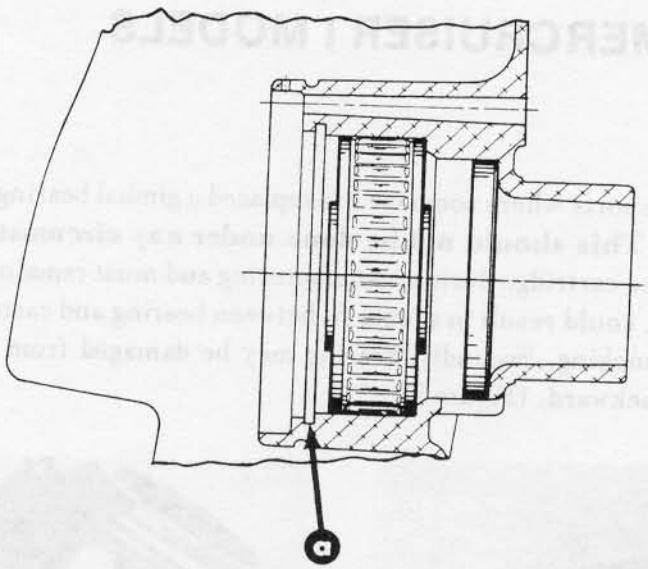
a - Hole in Bearing Must Align With Groove in Cartridge

Figure 2. Bearing Installation

To help ensure that the bearing is replaced as an assembly, current production MerCruiser 120-thru-300MR models have the gimbal bearing assembly installed with the bearing removal and installation slots (Figure 1) inward. Bearing can no longer be removed from the cartridge while installed in gimbal housing. If replacing a gimbal bearing assembly, the new assembly also should be installed in this manner.

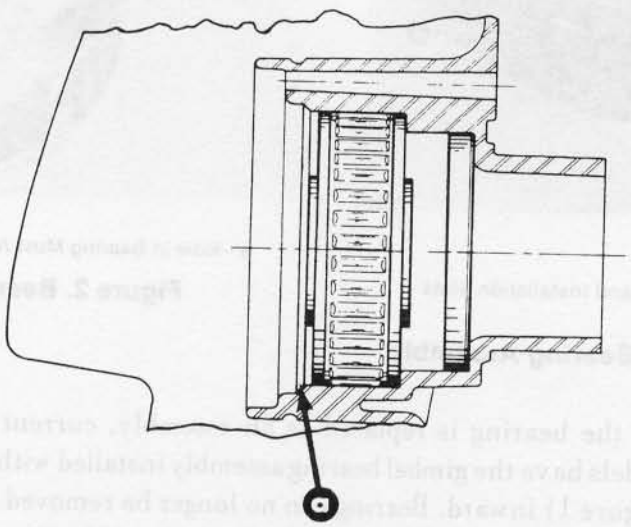
If a gimbal bearing assembly is to be reused, the tolerance ring (Figure 1) should always be replaced. It is essential that a tight fit be maintained between gimbal bearing cartridge and gimbal housing. A loose fit could allow bearing assembly to spin in the gimbal housing and/or cause U-joint knocking type noises.

When installing a gimbal bearing assembly, be sure bearing is fully seated in gimbal housing. **Cartridge must be pressed in past snap ring groove or lead in chamfer in gimbal housing,** as applicable. (Figure 3 or 4) Failure to do this, could cause U-joint yoke to contact bearing in turns with subsequent U-joint knocking resulting.



a - Cartridge Must Be Pressed In Past Groove

Figure 3. Gimbal Bearing Assembly Installation In Gimbal Housings With Snap Ring Groove



a - Cartridge Must Be Pressed In Past Lead In Chamfer

Figure 4. Gimbal Bearing Assembly Installation In Gimbal Housings Without Snap Ring (R & MR Models)